MUSICAL APTITUDE

AND SECOND-LANGUAGE PHONETICS LEARNING:

IMPLICATIONS FOR TEACHING METHODOLOGY

by

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ABSTRACT

In this thesis I have explored the relationship between musical perception and speech perception as well as that between music production and speech production. I conducted four tests: music perception, speech perception, music production and speech production. The participants were 92 students at Simon Fraser University studying French at beginner and intermediate levels. First they completed a same/different music perception test for tone and rhythm, 40 pairs for tones and 40 pairs for rhythm. Subsequently, the students undertook a speech perception test in which they had to perform a two alternatives forced choice paradigm task for three pairs of vowel contrasts ([y/u, ã/õ, e/ɛ]). The third and fourth tests examined both the musical production ability and the speech production ability by means of a musical production test and vowel production test. For the music production test, the students were directed to listen to the first of five pre-selected tones and to reproduce orally what they had heard; the reproduction was recorded. This was repeated for the other four tones. The five pre-selected tones used for male participants were different from those used for female participants. For the vowel production test the students listened to a pre-recorded list of thirty monosyllabic words containing the vowel contrasts studied in the speech perception test; subsequently, each student was recorded while reading this list of words. The advanced groups were also asked to produce an extemporaneous extract, of about thirty seconds duration, describing their morning activities.

Two hypotheses were tested in this study. The first assumed that there is a positive correlation between music perception and the perception of the sounds of a second language. The second hypothesis supposed that there is a positive correlation between music production and the pronunciation of sounds of a second language.

The results provided evidence of a correlation between music perception (rhythm) and speech perception, between music perception (rhythm) and accent production, between music production and speech perception, and between music production and accent production. Thus it was concluded that both hypotheses received support.

The purpose of this study was to learn more about individual differences in the acquisition of the pronunciation of a second language; this could possibly lead to a proposal for a better way to teach a second language. A correlation between music and speech suggests that students with musical aptitude could benefit from an approach that would emphasize listening to speech and music. The students without musical aptitude could be directed towards a more phonetic and more corrective approach.

This thesis is dedicated
to
my son Matthew

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CHAPTER ONE: INTRODUCTION

1.1 Objectives of the Research

While teaching French as-a second language for the past fifteen years at Simon Fraser University and other institutions, the author has observed a great difference between students in the same classroom. Some of these students had very little previous contact with native French speakers, had never lived in a French environment and yet seemed to have a facility for speaking French with little or no English accent. Alternatively, other students had attended French programs in Quebec, had French friends and practiced speaking regularly, yet retained a strong English accent. Even after many hours of laboratory and teamwork practice during the course of one semester, this latter group of students improved only slightly. As expected, the first group of students not only had little difficulty at the outset, but apparently improved with ease. Why would one group of students struggle with the accent of a second language, while the other group acquired it with apparently very little effort?

Several factors, such as interest, intelligence, L1 (mother tongue), sex, age, immersion and musical aptitude, might influence the acquisition of a second language. The participants chose to study French, and hence should be interested in the topic; their being university students indicates that they have been evaluated as above average intelligence throughout most of their schooling. Most students in French classes attending Simon Fraser University at these levels are female and most of them are in their early twenties.

In examining this question from the perspective of musical aptitude, some light might be thrown on the issue of why two persons of similar age of learning, same first language (L1), same background and similar intelligence and education, could have a very different capacity for learning a second language.

Although music training and immersion examined in this study might play a role in second language learning, I was mostly interested in the student's aptitude for music, independently of the student's musical experience. One student might have a very good potential for music without having played any musical instruments, whereas another might have extensive musical experience and yet have less or no musical aptitude compared to the musically naïve student (Jacobsen & Imhoof 1974).

1.2 Hypotheses

In order to better understand the relationship between second language learning and musical aptitude, two hypotheses were tested:

1. There is a positive correlation between music perception and the perception of sounds of a second language. This hypothesis is based on research findings such as those of Tomatis (1991), Arellano & Draper (1972) and Fish (1984); for details see section 1.3.2 (Tomatis) and 1.3.4 (Arellano & Draper and Fish).

2. There is a positive correlation between music production and the pronunciation of sounds of a second language. This hypothesis is based on the findings of Purcell & Suter (1981), which show a strong correlation between aptitude for oral mimicry (musical mimicry) and L2 pronunciation accuracy (Chapter 1.3.4). Further, this hypothesis was developed on the basis of discussions with students in several classes in which the capable second language speakers believe themselves to be good in music, whereas the students who had the most difficulty in pronunciation believed themselves to be poor musicians or singers. Preliminary research (Morgan-Carter 2001) also pointed to a correlation between music production and speech production.

1.3 Background Research

Major (2001) lists several personality factors that might explain individual differences between students learning a second language. These factors comprise empathy, motivation, sense of identity, ego permeability, self-esteem, risk taking, anxiety, introversion and extroversion, musicality, and socio-linguistic factors. This study examines the effect of music, in particular musical aptitude and music training, as factors relevant to the prediction of success in second language acquisition.

In this chapter I will review previous and ongoing research pertaining to music and language, music in language classes, music training and second language learning, and musical aptitude and second language learning.

1.3.1 Music and Language

In comparing the acquisition of music and the acquisition of speech, one must take into consideration the similarities between music and speech. Jean-Jacques Rousseau (1781) suggested that languages originated from music. According to him, for people from the warmer climates, where life was not overly stressful, music was used to express emotion; for people from the colder climates, where life had to be more organized, sound and meaning became separated, and language became more symbolic.

Graham (1969), on the other hand, describes foreign accent as being engendered by "speaking one language with the music of another, usually of one's mother tongue". (p. 446)

Music and spoken language are aural phenomena and thus have some similar characteristics that can be used in teaching a second language; the rhythm and melody of

the music can be compared to stress and intonation (Arleo 2000). Music and language can be divided into a hierarchical structure; for music, this structure proceeds from the larger constituent of a musical composition to the individual note, and for language, from large discourse units to phonemes. Another similarity, suggested by Arleo, is that they follow a time line.

> The temporality of music, spoken language and other kinds of performances, such as plays, poetry readings and dance, provides social cohesion by tying the participants together in a bounded collective experience. (Arleo, 2000, p.7)

Arleo (2000) explains that in the relationship between music and language there is a speech-song continuum. This continuum starts with speech, then moves on to heightened speech (storytelling, poetry recitation...), then to chants (chants, children's rhymes...), and finally to songs that he describes as a 'hybrid between language and music'.

Fonseca Mora (2000) also believes that music and language have several characteristics in common, such as sounds, messages, and exposure.

> Music and language share several features. On the one hand, both stem from the processing of sounds; on the other, both are used by their authors/speakers to convey a message, although language is much more precise than music, whose effect is mainly emotional. On another level, music and language have intrinsic features in common, such as pitch, volume, prominence, stress, tone, rhythm, and pauses. Another shared feature of language and music is that we learn both of them through exposure. No language can be acquired without oral or written input (or visual input, in the case of sign language), and in a similar fashion we acquire our notions of music from what we hear around us. (Fonseca Mora 2000, p. 147)

Deutsch (1991) demonstrated that there is a relationship between perception of musical tones and linguistic background. The notes used in Deutsch's experiments are

complex tones containing all octaves of a fundamental frequency. There are twelve fundamentals in all corresponding to the twelve notes of the chromatic scale. Notes are presented in pairs whose fundamentals are separated by tritones (six semitones or one-half octave). Participants were asked to identify which of two tones had the higher fundamental frequency (pitch). It is interesting to note that people from England perceived frequency values opposite to those from California. "If a Californian thinks that a C is above an F sharp, the Britisher will swear that F sharp is higher than the C" (Seife 2000, p. 2052). It is also interesting that both recently-arrived Vietnamese in California and those immigrating a long time ago perceived the tones in the same manner, but differently from Californians. Thus, if the two groups of Vietnamese perceive the C above the F sharp, the Californians will perceive the F sharp higher than the C. This research provides some interesting information implying a relationship between music and language. According to Deutsch:

> Concerning the musical implications of these findings, we can conclude that under certain conditions at least, perception of music can be strongly influenced by the language spoken by the listener. (Deutsch 1991, p. 345)

Another factor that shows that there exists a relationship between music and language is *amusia* – "an inability to perceive music..." (Balter 2001, p.1636). In their study of adults suffering from amusia, Peretz et al. (1998) show that the only factor to correlate with this musical deficiency is a difficulty in perceiving pitch variations in speech. Therefore, if an inability to perceive music predicts a difficulty in perceiving speech, then there exists a correlation between music perception and speech perception

In English, rhythmic structures influence the meaning of segments, as Palmer & Kelly (1992) exemplified by the phrases "the black-bird" and "the black bird". Two of

the prosodic rules of English are used to explain the difference in stress pattern between the two expressions. The Compound Rule of English, which states that for compound words the stress is placed on the leftmost word, and the Nuclear Stress rule of English, which states that the primary stress will be placed on the last word of a phrase. Palmer & Kelly (1992) state that "Similarly in music, rhythmic structure or patterns of accent strength affect the relative importance with which musical events are interpreted." (p.525).

Although some authors, such as Arleo (2000) and Deutsch (1991), agree that there are numerous similarities between music and language, there are others who find numerous differences. In her study on brainwave responses, Besson (1998) concluded that brain activities for language syntax and prosody are similar to brain activities for harmony, melody and rhythm. On the other hand, the brain activities for semantics seem to be specific to language.

> La conclusion principale est que le traitement sémantique semble spécifique du langage, en cela que les changements de l'activité électrique corticale sont différents pour la sémantique et pour tout autre type de traitement. En revanche, les traitements syntaxique et prosodique sont associés à des variations du potentiel cortical similaires à celles enregistrées lors de la mise en jeu de traitements harmonique, mélodique et rythmique. (Besson 1998, p. 947)

1.3.2 Music and Language Class

Numerous authors (Olhaver 1998, Lowe 1998, Guglielmino 1986, Foster 1993 and Karimer 1984) assert the merits of music in the classroom: music for relaxation, concentration, motivation, cultural awareness, vocabulary acquisition, ear training and pronunciation. In this section I will describe the use of music in second-language classes. In the first part, I will review different approaches to the employment of music in the

language class. In a later portion of this section, I will scrutinize some experiments relating to the benefit of second language teaching.

Although most teachers make an attempt to introduce some variety in the language class, nevertheless many classes consist of drills, short dialogues and repetition. "ESL instruction, regardless of its focus, involves a great deal of drill and repetition" (Guglielmino, 1986, p.19). Because music allows repetition in a pleasant manner for the student, it has a great importance in a language class (Guglielmino 1986). According to Guglielmino, not only does music alleviate the boredom of drills and repetitions, it also accommodates the different learning styles of many of the students. Some students might prefer reading and writing, while others would prefer listening, verbalizing, observing, touching, moving. We may add that views, such as that of Guglielmino presented here, are no longer considered to be valid.

> As is evident, the use of songs in ESL instruction could address a large number of these learning styles simultaneously, thereby maximizing the impact of instruction for the group. The learners have the opportunity to see the words (print), hear the words and music (aural), sing the songs (interactive), and clap or move their bodies to the rhythm of the music (kinaesthetic). (Guglielmino 1986, p.21)

Music allows students, even those with no musical aptitude, to learn vocabulary in a pleasant manner. Students, children as well as adults, after learning a new and popular song, can continue to practice their vocabulary by singing the song in or out of the classroom. Some methods, such as *Suggestopedia* (Bancroft 1982) and the method of Tomatis (Tomatis 1991), use carefully chosen music to increase relaxation, thus allowing the students to learn more efficiently (see next paragraph below and p.9). Other methods, such as the Contemporary Music Approach (Anton 1990) and the KELP project (Johnson

et al. 1995), use popular songs to motivate students and create a more active atmosphere in class (see below, p.11).

The Tomatis method (Tomatis 1991, Bancroft 1982) is employed to help children with aphasia or dyslexia. It is also used to facilitate second-language learning. This method uses the "electronic ear" in two phases: "the passive phase" (listening) and "the active phase" (listening and speaking). The "electronic ear" is a listening and speaking device that can be used to filter various frequencies. While a child is listening to Mozart's violin music, little by little the lower frequencies can be filtered out by the "electronic ear", to leave, at the end of the training, only the frequencies above 8,000 Hertz. "According to the research that has been conducted by Tomatis and his associates, high frequencies bring about a state of relaxation, on the one hand, and stimulate the cortex, on the other hand" (Bancroft 1982, p.13). For second language learning, the "electronic ear" is used to train the ear to the frequencies of the second language since, according to the Tomatis method, each language has a different frequency range.

> Statistical analyses of "English" English show that the native English speaker uses a frequency range that is between 1,800 Herz and 12,000 Herz. The Italian ear, meanwhile, can "hear" frequencies between 2,000 and 4,000 Herz while the French ear is tuned to hear frequencies between 800 and 1,800 Herz. (Bancroft 1982, p.19-20)

Lozanov (Bancroft 1982) created *Suggestopedia*, a teaching technique based on the principle that students will learn more efficiently if they are in a relaxed environment. Baroque music, yoga and classroom design can all be used to create such an atmosphere. The use of baroque music will improve progress principally for adults in intensive language classes (Schiffler 1986). A suggestopedic class is divided into three parts: (i) a review of what was learned during the preceding day, (ii) a "conscious analysis" and (iii)

a "relaxation session". The review is achieved through different aural-oral activities, including singing. The second part, called "conscious analysis", comprises reading, grammar and translation. The third part, "séance" or "relaxation session", views the new information in an unconscious manner. The third part is divided into an active phase consisting of reading and repeating, and a passive phase consisting of a two-minute introduction to Bach, slow movements from baroque music (lasting twenty minutes), and an allegro movement played on a flute.

> The lyrical and rhythmic music, the artistic and rhythmic rendering of the text by the teacher, the rhythmic, deep breathing and meditative state of the students ("concert pseudo-passivity") contributed to a marked decrease in fatigue and tension and a marked increase in the memorization of foreign language materials. (Bancroft 1982, p.8)

Anton (1990), describes how the CMA (Contemporary Music Approach) uses songs in a Spanish classroom.

> CMA takes advantage of music – one of the most effective memory aids available to us. Through the songs, students learn rhythm, intonation, and pronunciation in a natural way as they listen to the music over and over and then attempt to reproduce the sound they hear. (Anton 1990, p.1169)

This approach is based on music being a very effective memory tool. In Anton (1990), the songs were composed by the author and performed by three lead singers, a choir and many musical instrumentalists. In the first phase, the memory phase, students listen and join in the singing. In the second phase, the students write their own lyrics to the same melody in the second language. The author explains that such use of music not only motivates the students, but also encourages creativity and emotion. After attending Spanish classes that implemented this approach, the students completed a survey, the

results of which showed that most students enjoyed learning in this manner and that many continued singing the songs they had learned and created. According to the author, this improved their rhythm, intonation and pronunciation of Spanish.

Arleo (2000) gives several reasons for the benefits of music used in a foreign language class: it is entertaining, and hence a great tool for listening, pronunciation, vocabulary and grammar exercises; it 'sticks to our heads', teaches about a foreign culture, and leads to discussion and communication. Arleo describes how there are many activities to be performed with a song other than just listening and singing. There is a vast quantity of questions that can be used as a 'prelistening activity' in which students can ask one another about their taste in music and their appreciation of songs in a language class. A class discussion in the second language can follow in order for the teacher to learn what the students' favorite song is. After the listening activity, the students can also be asked questions about the song they heard, such as: which instruments were used, from which country the singer came, and which emotion the song portrayed.

> Because it is both similar to and different from language, music is a valuable and enjoyable tool in a foreign language classroom. It reinforces classroom cohesion, engages the whole body through a shared rhythmic pulse, and appears to mobilize (partially) different patterns of neural resources. Songs, in particular, contribute to better pronunciation (especially in regards to prosody), develop fluency, facilitate the comprehension and the memorization of vocabulary and grammatical structures, and promote awareness of the target culture. Above all, music and song can be used creatively by teachers and learners in relation to their own goals. (Arleo 2000, p. 18)

Twenty-five adult immigrants, learning English as a second language, were tested by Karimer (1984) using same-different pre-tests and post-tests. The students were divided in two groups: a control group, which did work on minimal pairs, a minimal pair

being a pair of words that are separated by only one phoneme, and the experimental group, which studied with songs and rhythmic chants. The results show that an experimental group achieved significant statistically better scores in its post-test than the control group. On the pre-test the mean scores of the control group and experimental group were 67.7% and 63.3% respectively, whereas the corresponding scores for the post-tests were 71.6% and 73.3%.

The KELP (Kanda-English Language Proficiency) project (Johnson et al. 1995) in which adult students plan their own English studies, uses three kinds of material: database/video, reading and music. Popular music is used, since it is an easily available motivational tool that the student will listen to and transcribe.

> First, music is a popular theme amongst students. Activities and materials related to the topic are of high interest to the students and thus have a greater inherent motivational value to them. Moreover, there are a variety of music media available today such as video, CDs, cassettes, and printed matter that are ideally suited for use in an instructional system such as the KELP classroom. (Johnson et al. 1995, p.5)

A study by Techmeier (1969) demonstrated that a group of American students showed an improvement in French pronunciation after joining a choir at Laval University. "Singing tunes the ear to the delicate shades of sound besides promoting articulation of words and focusing attention on proper accentuation". (p.96).

Willis & Mason (1994) recommended the use of Spanish versions of English songs, as well as songs from Hispanic countries; the former is already a part of the student's culture and can be used as a motivational factor, whereas the latter can introduce a new culture. According to Willis & Mason, both types of songs are good

practice for learning to understand, speak, read and write in the second language, but using both types of songs helps the student understand more about the culture:

> [Hispanic songs] provide exposure to the Hispanic culture, and Spanish versions call attention to the growing presence and influence of Hispanic culture in the United States. (Willis & Mason 1994, p.102)

Pinel (1990) agrees with Foster (1993) and Arleo (2000) that music is a motivational factor:

> In order to motivate anyone, child or adult, to want to learn a new skill, one starts with a known element. Music is an ideal vehicle since hearing is the first of the senses to develop, and a child is naturally interested in rhythm and musical sounds (Pinel 1990, p.37)

Pinel also explains that songs "can relieve the tedium associated with repetitive skill" (p.37), since students often continue singing or humming a song even after school. This will, according to Pinel "develop aural and oral skills", and after a certain time, this repetition will generate "auditory retention". Music also "develops auditory perception and discrimination", vocabulary and cultural enrichment. By listening to a song, children will become acquainted with the pronunciation and rhythm of the singer; they will be encouraged to learn a new vocabulary and, if the songs are well chosen, a new culture.

Adkins (1997) does not adopt the viewpoint of Lozanov and Tomatis, since it is neither baroque nor classical music but rock music that she plays for her eighth graders. She agrees with Arleo (2000), Guglielmino (1986) and Pinel (1990), that music, if chosen appropriately, can be used to teach listening, vocabulary and grammar, and that the use of modern music will motivate the students, since students can relate to this music.

The studies referred to above have demonstrated how music helps with relaxation, develops aural and oral skills, allows for different learning styles, motivates the students

and relieves them from the boredom of repetition in a language class. The experimental research section has also demonstrated the success of using music for teaching a second language.

1.3.3 Music Training and Second-Language Acquisition

The above survey confirms that music is a valuable component in second-language teaching classes. Does this signify that a background in music is an asset for learning a second language? If, as stated by Pinel (1990), listening to songs in a second-language class facilitates the improving of auditory discrimination, it could be assumed that playing a musical instrument or singing in a choir also enhances auditory discrimination by improving the acuity of the student's ear.

The authors to be referred to in the present section were interested not only in the relationship between listening to a song in an L2, and the acquisition of this L2, but also in the effect of music training on second-language learning for both adults and children, regardless of the language studied.

Lowe (1998) studied two classes of Grade 2 French-immersion students, one class with music lessons integrated into the second-language course and the other class without integrated music lessons. The goal of the French tests was to measure the pronunciation by the reading of a text, the oral grammar by placing orally some words in the right order, the comprehension by answering questions corresponding to a text and the vocabulary by choosing the correct word in a sentence. The music test was divided into a written section for description in which the student was asked to choose which of the pattern represented the best the music heard, a composition section and an interpretation section. The results indicated no significant differences between the two groups at the pre-test ($F[1] = 0.10$,

$p<.755$); however the difference was significant for the post-test ($F[1] = 5.55$, $p<.05$). The group receiving the music lessons performed significantly better in music, as would be expected, as well as in oral grammar and reading comprehension tests of French.

Harrison (1979), in her M.A.T. of French tested 83 Grade 8 students to determine whether there is a difference between the performance of students who were practicing music and students who were not practicing music in the acquisition of French as a second-language. She gave the students four tests, two dealing with patterns of intonation used in French and two with the pronunciation of French words and phrases. Each test had from three to four sections. The results presented in Table 1[1] show that the students who had music training were generally more successful in French pronunciation-discrimination and pronunciation-performance than those students who had not.

Table 1. A comparison of the scores of students with and without music training

	Music	Non-music
Test 1 Intonation		
Section I	11.90 / 15	10.19 / 15
Section II	2.16 / 5	2.18 / 5
Section III	6.84 / 10	5.97 / 10
Test 2 Pronunciation-discrimination		
Section I	7.94 / 10	7.89 / 10
Section II	6.96 / 10	5.67 / 10
Section III	8.84 / 10	8.56 / 10
Section IV	3.53 / 5	2.48 / 5
Test 3 Pronunciation-performance		
Section I	24.23 / 33	22.39 / 33
Section II	12.63 / 20	11.26 / 20
Section III	14.50 / 20	12.89 / 20

Test 4 Intonation-performance		
Section I	8.82 / 9	8.74 / 9
Section II	10.24 / 11	9.32 / 11
Section III	9.34 / 15	7.42 / 15

The studies by Lowe (1998), Harrison (1979), and Eterno (1961) show that musical training has a correlation with second-language acquisition for children (discussed in more detail in Section 1.2.4). Nevertheless, the findings by Stokes (2001) show this not to be the case for adults. Stokes tested 37 undergraduate students of upper division Spanish in order to discover which factors might influence the acquisition of Spanish. A Spanish pre-test was given at the beginning of the ten-week course, followed by a post-test at the end of the ten weeks. The tests consisted of reading, describing pictures and expressing an opinion on a current event. The results revealed that in the pre-test, only attitude was significant, whereas both attitude towards the second language and residence (immersion or non-immersion) were significant in the post-test. There was no significant correlation between music training and second-language acquisition. In his conclusion Stokes suggested that there might be a greater correlation between musical aptitude and second-language acquisition than between music training and second-language acquisition.

The discrepancy in the correlation between music training and second-language acquisition for children and adults requires further investigation. Perhaps at a younger age musical training might have a greater influence on a developing auditory system, whereas for adults, this capacity has already been developed, if this training was received when they were already adults.

1.3.4 Musical Aptitude and Second-Language Learning

Purcell & Suter (1981) studied 20 variables for predicting the acquisition of English pronunciation by non-native speakers. Four factors were correlated with pronunciation accuracy: L1, aptitude for oral mimicry, residency, and the extent to which the speaker was concerned with L2 pronunciation. Of these four factors, oral mimicry is the most relevant to our study, since:

> Aptitude for oral mimicry seems beyond the control of the instructor; it is doubtful that one can make a good mimic out of a naturally poor one. This seems to match the common view that some people simply have a better "ear" for pronouncing languages, and that there is not a great deal language teachers or learners can do about it. (Purcell & Suter 1981, p.286)

In this section, I will first compare the "ear" for language with the "ear" for music, and then compare the capacity to mimic in language with the capacity to imitate in music. I will also distinguish between musical aptitude and musical training and then present experiments on the relationship between musical aptitude and second-language acquisition.

Although musical training appears to be related to success in second-language learning (see discussion above), it is of the utmost importance to discriminate between musical aptitude and musical training, since, as stated by Jacobsen and Imhoof (1974), musical training is not always related to musical aptitude. Some people might study music for a very long time, improve their musical achievement, and yet remain inferior to others who have never studied music but who have a greater aptitude for musical perception, discrimination and production. Jacobsen & Imhoof (1974) tested certain factors that might help predict the success that a student learning Japanese as a second language will achieve. Six hundred missionaries who were residing in Japan, and had

studied Japanese intensively for at least two years, were evaluated on the basis of six extra-linguistic factors: multi-linguality, semantic space sensitivity, Japanophilia (adaptation to Japan), formal education, musical training and the introduction of *kanji* (Japanese characters based on Chinese ideographs).

The results showed that there is a positive correlation between childhood multi-linguality and proficiency in Japanese. There is also a positive correlation between proficiency in Japanese and semantic space sensitivity; the term semantic space sensitivity refers to sensitivity to subtle differences between pairs of words -- Japanese and in another language -- in the translating of one language to another. There was no positive correlation between formal education and proficiency in Japanese. According to Jacobsen & Imhoof (1974), several factors that might influence success in second-language acquisition are included in formal education; for example, when examining the factor of formal education, it is important to consider that age might influence the results since the time spent acquiring a formal education will make the participants older. Formal education might therefore have a positive correlation with Japanese proficiency if it were not that formal education increases the age of the learner, which in turn might decrease the capacity for learning a second language. It was also shown that a more successful adaptation to the Japanese culture would bring a higher success in learning the Japanese language. The hypothesis that delaying the study of *kanji* would facilitate the acquisition of the spoken language could not be supported.

Musical training was another factor that was not found to be a correlate to Japanese language proficiency. Jacobsen & Imhoof (1974) remind us that "musical background is not necessarily to be equated to musical ability" p. 333. In their study it

was also suggested that pitch discrimination might not be a significant factor for all languages; it might not be overly important for the acquisition of Japanese, but could be of greater importance for another "more musical" language.

In 1961, Eterno tested students in the 6th, 7th and 8th grades to determine if a relationship exists between musical aptitude and second-language learning. Using the Conn Musical Aptitude Test (Eterno 1961, p.168), which tests rhythm chords, vision and mathematics; the students were tested by a music teacher and were awarded points from 1 to 5. The students were then trained in Spanish pronunciation and subsequently asked to repeat sounds pronounced by the teacher and to read certain words. Again, they were graded from 1 to 5. The scores for music and Spanish were then compared; they revealed that 59.6% of 6th graders, 60% of 7th graders and 76.7% of 8th graders had equivalent scores for music and Spanish. Furthermore, of the 6th graders who had an above average Spanish score, 57.2% had played a musical instrument for a year or more. The equivalent percentages for the 7th and 8th graders were 71.4% and 90%, respectively. Therefore, not only is there a possible relationship between musical *aptitude* and second-language acquisition, but also between musical *training* and second-language acquisition.

> On the basis of this study, it is evident that musical aptitude and musical training (one year or more) are important factors in foreign language pronunciation success. (Eterno 1961, p.170)

In their research, Pimsleur et al. (1962) attempted to find factors influencing the acquisition of a second language. The factors studied for the acquisition of French at the university level included the following: verbal reasoning, speed of articulation, pitch discrimination, timbre discrimination, interest and biographic factors. The pitch discrimination tests employed were the Chinese Pitch Perception Test (Pimsleur et al.

1962, p.21) and the Seashore Pitch Test (Pimsleur et al. 1962, p. 21), and the timbre discrimination test was the Seashore Timbre Test (Pimsleur et al. 1962, p. 21). As expected, the verbal factor and interest were the most important variables; nevertheless, reasoning, word fluency and pitch discrimination were also important factors for university level French language learning.

Arellano & Draper (1972) tested a group of children to investigate a relationship between musical aptitude and the acquisition of Spanish; they used the Seashore Measures for Pitch, Intensity, Rhythm, Timbre and Tonal Memory (Arellano & Draper 1972, p.120; Leutnegger & Mueller 1964, p.144; Pimsleur et al.1962, p. 16), as well as a multiple-choice comprehension test and a production test for Spanish. The participants, 75 in total, were all English-speaking 5th graders and approximately 10 years of age. These tests revealed a strong correlation between timbre and intonation, timbre and phones ($p<.01$). There was also a significant correlation ($p<.05$) between rhythm and intonation, between rhythm and phones, and between tonal memory and phones. The musical tests (timbre, rhythm and tonal memory) were perceptual tests whereas the Spanish tests for intonation and phones were production tests.

Brutter et al. (1985) tested musical aptitude (pitch, loudness and rhythm), auditory discrimination and memory, to determine which of these factors, if any, could predict success in ESL learning. To test musical aptitude, three tests from the Seashore Measure of Musical Talents (Brutter et al. 1985, p.301) were used: pitch, loudness and rhythm. The Seashore Test of Pitch is an auditory discrimination test in which the students have to perform a same/different task. The Seashore Test of Loudness requires the students to discern which sound of a pair is the loudest, and the Seashore Test of Rhythm requires

them to perform a same/different task. For auditory discrimination, the Wepman Auditory Discrimination Test (Brutten et al. 1985, p.302) was used, in which the students had to decide whether the pairs of words were the same or different, the different words varying only by a phoneme. All of these were listening tests. Also used were a sentence repetition test for memory and a Test of Spoken English (TSE) (Brutten et al. 1985, p.302). The participants were 52 adults of various L1 backgrounds, studying advanced English-as-a-second-language class. No significant correlation was observed between the results of the three musical aptitude tests and those of any of the TSE (pronunciation, grammar, fluency and the overall progress in learning). Brutter et al. explain that some of the results are realistic because the music test tested perception only, whereas the memory and TSE tests were production tests.

A study by Fish (1984) analyses several factors that might be responsible for individual differences in language learning: intelligence, attitude, motivation, cognitive style and pitch discrimination. Forty-five eighth-grade children, studying German at a junior high school in Minneapolis, were presented with the Edmonds Learning Style Identification Exercises (Fish 1984, p.25), the Pimsleur Language Aptitude Battery (Fish 1984, p.22), the Gordon Musical Aptitude Profile (Fish 1984, p.24) and the MLA Cooperative Foreign Language Test (Fish 1984, p.23; Pimsleur et al., p.16). Relationships were investigated (i) between pitch discrimination and sound discrimination, (ii) between pitch discrimination and pronunciation of phonemes in a second language, (iii) between cognitive style and second-language learning, and (iv) between age and the learning of new sounds in a second language. The results showed a strong correlation between pitch discrimination ability and sound discrimination. There is

also a correlation between sound discrimination ability and the playing of a musical instrument. There is no correlation between pitch discrimination ability and pronunciation ability of German phonemes, or between pronunciation ability of German phonemes and musical background (this result does not conform to the findings of Harrison). Finally, there is no correlation between sound discrimination ability and pronunciation ability of German phonemes (this result does not support the findings of Tomatis (1991) that in order to produce a phoneme one must perceive it properly). It would appear that music (pitch perception and playing a musical instrument) is related to language perception, but has little influence on language production.

The studies reviewed in the previous section reveal that there is indeed a correlation between music and second-language acquisition. Many researchers and teachers agree that music in the classroom will improve auditory skills, which could be relevant to learning proficiency (Pinel 1990), and that musical training improves the auditory capacity of children, and thus their second-language learning (Tomatis 1991). This correlation between music training and second-language acquisition appears to be lower for adults than for children; the playing of a musical instrument does not appear to modify an adult's second-language learning (Stokes 2001), but has a great influence on a child's second-language learning (Lowe 1998, Harrison 1979, Eterno 1961). Conversely, listening and singing in the language studied appear to promote the learning of pronunciation in a second language for both adults and children (Tomatis 1991, Techmeier 1969, Anton 1990).

When examining factors that influence the learning of a second language, attitude (the extent to which the student judges it important to imitate the pronunciation of a

native speaker) and length of residency (time spent in the second-language environment) are the most significant parameters (Stokes 2001).

While the relationship between musical aptitude and second-language learning has been widely investigated, it has to be recognized that most studies have focused either on the correlation between music perception and speech perception or the comparison between music perception and speech production. The present study aims at shedding light on the relationship between the production aspects of music and language, and on the implication for teaching methodology that such a relationship could substantiate. By relating music perception to second-language perception, we may be able to understand and predict success in second-language speech discrimination; this in turn, might enable us to understand and predict success in second-language phoneme production, as well as in accent production in general. Also, the study of the relationship between music production and phoneme production as well as between music production and accent production may contribute to our understanding of second-language teaching in terms of predicting success in second-language production. Therefore, examining music perception and production in relation to second-language learning may give us the knowledge necessary for understanding errors in production and perception in second-language classes and for the creation of a new curriculum adapted to the correction of errors.

1.3.4.1 Research on Musical Aptitude in Relation to the Teaching of French

Although there exists a large volume of research on the advantages of using music in a French class, in general, the focus has been so far on the usefulness of music in a

French language classroom, without quantitative evidence such as that presented in this study. The most influential works have already been referred to (see Section 1.3.2).

Techmeier (1969) has showed that joining a French choir helped native English adults learn French (see p.12). Other studies such as Arleo (2000) and Lowe (2002) show that using songs in French-as-a-second-language class increases the success in learning French. Lowe (1998) has described how Grade 2 French immersion students practicing a musical instrument performed better in oral grammar and in reading comprehension of French (see p.14), whereas Harrison (1979) explained how Grade 8 students who were taking some music training were more successful at learning French than students who did not take any music lessons (see p.14). Pimsleur et al. (1962) showed a relationship between pitch discrimination and the acquisition of French as a second language at the university level (see p. 18).

However, overall very little research exists that is relevant to musical aptitude and the learning of French as a second language.

CHAPTER TWO: METHODOLOGY

In this study I am concerned with examining the degree to which musical aptitude might correlate with the learning of a second language. I will use Gordon's definition of aptitude as a guideline: "Aptitude is a measure of one's potential to learn, and achievement is a measure of what one has learned" (Gordon 1979, p. 3). It is relevant to refer to here to a definition from a study by Cronbach and Snow (1977).

> To keep the problem as open as possible, "aptitude" is here defined as any characteristic of a person that forecasts his probability of success under a given treatment. (Cronbach & Snow 1977, p. 6)

Two hypotheses will be tested.

1. There is a positive correlation between music perception and language perception. Accordingly, a perceptual deficiency in speech might not be only a language problem, but also a problem of discriminating between rhythms and between tones for music, and between vowel contrasts for speech. As indicated above (p.2), this hypothesis is based on the study of Tomatis (1991), Arellano & Draper (1972), and Fish (1984).

2. There is a positive correlation between music production and speech production. Thus, problems in production might be due to difficulties in imitating what has been heard. Although a vast number of studies have examined the relation between music and speech (see chapter 1), I was unable to find research on music production in relation to speech. This hypothesis was set forward because of the results in Purcell & Suter (1981) (see also p. 16). Further, informal surveys with students indicate that there might be a positive correlation between music production and speech production.

In order to assess the relationship between musical aptitude and second-language learning, I asked the students to participate in a music perception test, a speech perception test, a music production test and a speech production test. The music perception test was divided into two sections: a rhythm perception test and a tone perception test. The speech perception test consisted of vowel discrimination tasks. The music production test

required repetition of musical notes. Finally, the speech production test was divided into two sections: a vowel production test and an accent production test.

2.1 Participants

All the participants were Simon Fraser University students attending classes in the Department of French. First and second year students were selected in a manner to control as many variables as possible. Most of them were in their early twenties and female.

The participants for this study were students from five classes. French 100 is taught to beginners (hereafter students participating in this project from this class will be referred to as Group A). The French 151 class is for beginner/intermediates (hereafter students participating in this project from this class will be referred to as Group B). The French 201 class is for intermediates (hereafter students participating in this project from this class will be referred to as Group C). French 270 is a French linguistics class and is a more advanced class (hereafter students participating in this project from this class will be referred to as Group D). French 205 is a French conversation class (hereafter students participating in this project from this class will be referred to as Group E). Since only a few students from group A and E came to the production tests, these two groups were eliminated from the study, leaving only group B, C and D.

Those students who had a hearing impairment, or any other problem that could influence the results of the study, were requested to enter this information on the questionnaire (see Section 2.2 and Appendix B). Their results were removed from the study.

2.2 Material

All students had first to complete a questionnaire (see Appendix B) requesting information relevant to their experience with the French language, information about their mother tongue or other language(s) spoken, and, when applicable, information about their musical experience. The experiment then proceeded with the administration of four separate tests.

2.2.1 The Music Perception Test

The "Intermediate Measure of Music Audiation" (Gordon 1986) was chosen for this part of the experiment, since it can be used with students who possess absolutely no experience with music (have never taken a music class and never played a musical instrument). This test is more modern than other common tests such as the Seashore Tests of Musical Talent (1960). It is also easy to administer and comprises two tests each of twenty minutes only. Another test by Gordon ' Music Aptitude Profile' could also have been used but the length of the test, 3.5 hours, prevented us from using it since it would have taken too much time away from the class. Also, another advantage of using the "Intermediate Measure of Music Audiation" is that it tests musical aptitude without testing musical memory since the responses are immediate.

The test is administered on a CD containing 40 pairs of tone samples and 40 pairs of rhythm samples. Each pair of tones is a series of tone, which might differ by one or more tones. Each pair of rhythms is a series of notes; the series may or may not differ by their rhythm. The test comes with an answer sheet designed for young children

(Appendix C and D), so an age-appropriate alternative answer sheet (Appendix E) was designed listing the words heard on the CD with a space for the students to write S (same) or D (different). Students listen to the pairs and decide if they are the same or different.

2.2.2 The Speech Perception Test

In the speech perception test, a vowel discrimination task, the participants listened to a pre-recorded cassette containing 30 open-syllable monosyllabic words spoken by a native speaker of Canadian French. Ten of these words contained the [y/u] contrast, ten the [ã,õ] contrast, and ten the [e/ɛ] contrast. These vowel contrasts were chosen because, on the basis of my personal experience of teaching French as a second language, they appear to be the major errors made by the students[2]. The words were randomized and were not presented in pairs.

Monosyllabic words were chosen for their simplicity and to avoid the tendency of students to use the English stress pattern in a French word. The students were given an answer sheet on which they placed a check mark in the column under the perceived sound. To assist the students to better understand which column referred to which sound, the letters typically representing these sounds were written, together with a short word containing this sound, as an example at the top of each column. The letter 'u' and the word 'rue' represented the sound [y], the letters 'ou' and the word 'roue' represented the sound [u], and so on (Appendix F). Letters were used rather than phonetic symbols because not all the students were familiar with the phonetic symbols. This approach was based on the 'Sound to letters Perception technique', as the 'Sound to phonemic symbols'

technique was not applicable (Lado 1961), the students of French 270 (French linguistics) being the only group familiar with phonetic symbols.

2.2.3 The Music Production Test

In this test, the students listened to a recording of five different digitally produced musical notes. The students listened to one note at a time and attempted to reproduce it as closely as possible.

To ensure that these five notes would lie within the range of capability of both male and female students different criteria were chosen for different genders. For females the criterion was that the notes should lie within the ranges of both contralto and soprano singers. The fundamental frequency range for an alto is from 125 Hz to 660 Hz and the frequency range for a soprano is from 220 Hz to 1046 Hz. In order to account for the range of all female students, I used notes with frequencies between 220 Hz and 660 Hz.

For the males, these five notes were required to lie within a region common to bass, baritone and tenor. The frequency range for a bass is between 82 Hz and 330 Hz, the frequency range for a baritone is between 98 Hz and 350 Hz and the frequency range for a tenor is between 125 Hz and 440 Hz. In order to account for the range of all students, I used notes with frequencies between 125 Hz and 330 Hz.

The range for both male and female participants was somewhat greater than one octave. It appeared possible that the male and female participants could sing the same notes, but with female participants singing one octave higher. By using the same five notes for both male and female participants, the tests would be somewhat simplified. This provided a little more than one octave for selection of the five frequencies, which were then presented to the participants randomly. The frequencies of the notes were based on a

current music pitch of A = 440 Hz[3], which was recommended as the standard frequency by the International Standards Organization in 1953. A = 440 Hz is the A above middle C[4].

The women used the following randomly-chosen musical notes with equal temperament frequency[5]: D# (Re sharp) 311 Hz, G (Sol) 392 Hz, A (La) 440 Hz, B (Ti) 494 Hz, C# (Do sharp) 554 Hz.

The men used the following randomly-chosen musical notes with equal temperament frequency[5]: D# (Re sharp) 156 Hz, G (Sol) 196 Hz, A (La) 220 Hz, B (Ti) 247 Hz, C# (Do sharp) 277 Hz.

The Goldwave digital audio editor, version 4.26, was used to create the musical pure tones for the music production test. These notes were then recorded and played back for the students on a JVC tape recorder. The participants' production tokens were recorded using a Highball unidirectional dynamic microphone, Genexxa Intertan. These tokens were subsequently digitized using the Sound Edit soft ware, Version 16. The sound analysis program, Praat 3.9.28, was used to analyze the music production extract. A Mac OS computer was used to digitize the target notes as well as to record the students' music and speech extracts.

2.2.4 The Speech Production Test

The speech production test was a vowel production task. The students listened to a soundtrack of the same 30 monosyllabic words used for the speech perception test as produced by a native speaker of French. The students were then recorded while reading this list of monosyllabic words. These recordings were subsequently presented to a native speaker of French in the same format used in the speech perception test. The native

speaker of French listened to the recording and completed the same answer sheet that had been previously given to the students for the speech perception test. For each word, she had to decide which vowel of the vowel pair the student had pronounced. The answer sheet of the native speaker of French was then compared to a correction sheet and a score was given to each student. In the speech production test, a JVC tape recorder was used for both the soundtrack of the native speaker of French and the student's recording.

A PC Windows XP was used to analyze the data of the four tests.

2.3 Procedures

A language background questionnaire was completed by all the students in their classroom prior to the two perception tests. This questionnaire obtained background information on the students concerning L1, music training, immersion classes attended, and travelling to a French city. The factors of music training and immersion classes attended were investigated in our study in addition to the variable of musical aptitude. The choice of these two additional variables was based on research by Lowe (1998), Harrison (1979), Eterno (1961) and Hammerly (1989) who found they were relevant to second-language learners.

2.3.1 The Music Perception Test

This test was carried out in the classroom. The students listened to a CD recording of "Intermediate Measure of Music Audiation" by Gordon (1986) (for the material being tested see page 27). Each token was presented only once, because this would exclude the possibility of memorization. The answer sheets (Appendix E) were graded according to the "Intermediate Measure of Music Audiation" correction-sheet. Each student was

awarded a score out of 40 for each exercise, resulting in a score out of 80 for the two exercises. The answer sheet asked the students to listen to the two series of tones and to assert if these tones are the same or different; this was repeated 40 times. After listening to the forty pairs of tones, the students were asked to listen to two series of notes and to assert if these two series have the same rhythm. A few examples were given to the students before each test.

2.3.2 The Speech Perception Test

The vowel discrimination task was also conducted in the classroom, following the music perception test (see description of test material on p. 27). The test was performed in a sound-treated room and the students did not need headphones. Ten of these words contained [y/u] contrasts, ten [ã/õ] and ten [e/ε]. The participants were asked to perform a two alternatives forced choice task. (Appendix F). The test was scored out of 30.

2.3.3 The Music Production Test

Many of the studies pertaining to the relationship between second language learning and music have used the "Seashore Measure of Musical Talents"[6] test (Leutnegger & Mueller 1964; Brutten et al. 1985), which measures only the perceptual ability of the student, and not the ability to produce or reproduce what is perceived. Eterno (1961) 'examined the relationship between the perception of rhythm and the repetition of words and sounds. Brutter et al. (1985)' investigated musical listening aptitude in relation to repetition and spoken English. Arellano & Draper (1972) [6]examined the relationship between music perception and the perceiving and production

of Spanish phonemes (not the accent), while Fish (1984)[6] studied pitch discrimination in relation to phoneme discrimination and phoneme production.

The relationship between music production and speech production is the crucial part of this study. Most of the studies pertaining to the relationship between music and second-language learning (summarised above) have tested the relationship between music perception and speech production, as well as between music perception and speech perception. None has tested the relationship between music production and speech production. I therefore felt justified in carrying out a music production test in order to examine our second hypothesis, which proposes a positive correlation between music production and speech production. The test had to be very simple for the students to perform, since it had to assess both music-proficient and music-naïve students. It was impossible to ask musically naïve students to sing the note "doh", for example, since they might not know the sound of "doh". I therefore decided that the easiest approach would be for them to merely repeat the sound they had just heard.

In order to obtain suitable recordings, the music production test was performed individually in a sound-treated phonetics laboratory. Each student listened to a recording of the five tones. After each tone, the student sang the note just heard, using the word "la" [la][7].

Each student's production was presented to a graduate music student from Laval University, who rated the productions from 1 to 5, one being a poor imitation of the note heard and 5 being excellent. The final score was out of 25, as each student sang 5 notes.

To confirm the graduate student's results, the program Praat 3.9.28 was used to determine the fundamental frequency of each of the notes sung by the participants. I

arbitrarily decided that if the fundamental frequency of a student's note was more than one tempered semitone interval from the target frequency, then (s)he would be awarded a mark of zero. As I wished to award a mark of 0 to 5, where 5 was very good and zero very poor, I partitioned both the upper and lower tempered semitone intervals into five geometrically equal sections. If the tone that was sung lay between the target frequency and the first upper or lower partition, a mark of 5 was awarded; if it lay within a second section a mark of 4 was awarded, and so on[8].

Similarly, marks were awarded to a subject for the other four target frequencies. The addition of these marks (0 – 25) was then used as a gauge of the student's performance. The performance of each subject was assessed in the same way.

Although the results obtained by the graduate student and the results obtained by using the program Praat were very similar, I decided to use the results provided by the graduate student, since she could take into account students who sang close to a note, but in the wrong octave.

2.3.4 The Speech Production Test

Graham (1969) suggested that an accent in a second language might be due to the problem of imitating the sounds of that language.

> Speaking with a foreign accent is due to the transference of varying degrees of the music of one language to another. This is usually from one's mother tongue to the foreign language. In the case of an actor speaking with a foreign accent the process is reversed. In the first case the accent or "wrong" music is due to lack of imitative ability. In the second case it is due to perceptiveness and imitative talent. (Graham 1969; p. 448)

This was tested by Purcell & Suter (1981) who studied the correlation between English pronunciation and 20 extra-linguistic variables. They concluded that four

variables were good predictors of success in English pronunciation: mother tongue, residency (time spent in an English city), strength of concern for pronunciation accuracy and *aptitude for oral mimicry.*

The participants in the present study were asked to perform two production tasks: a vowel production task (for a description see p. 29) and a conversation. A French Canadian listener was chosen to score the vowels for intelligibility, since most students were more acquainted with the French Canadian accent (the author's accent) than with the French from France or other dialects of French.

In the second task, the relationship between music and accent production was tested. The two most advanced groups of students (French C and D) were asked to record themselves talking about their activities on that day. In order to produce a natural extract, they were instructed to speak for about 30 seconds but without being told what part of their speech would be graded. Only the advanced groups performed this task, since it would have been too difficult for the others. These extracts were graded for their French accent from one to five by two native speakers of Canadian French, a mark of one being very poor and a five being the equivalent of a native speaker. The native speakers of French were asked to pay attention only to the "accentedness" and to ignore both the grammar and the difficulty of understanding the meaning of the extract. "Accentedness refers to how strong the talker's foreign accent is perceived to be." (Munro & Derwing 1995, p. 291)

A within-group correlation test was performed for the three French groups (B, C, and D), which related music perception to vowel discrimination and also music production to vowel production. The two most advanced groups were also studied for

correlation between music production and accent production. It was decided, after discussions with a statistics consultant, that if the correlation coefficients for the results of the three groups (French B, C and D) were similar, they should be analysed as one group.

In order to study the effect of music training on second-language acquisition, I compared the average speech perception scores of the students who had music training and of those who had none. I then compared speech-production scores, as well as accent-production scores, for students with and without music training. It was decided that students with less than three years of musical training would be considered as not having had any musical training and students who had taken three years or more of musical training would be considered as having had musical training. This number of three years was chosen because there appeared to be a natural separation among the students. Many students had absolutely no training or one year of training and many students had more than seven years of training.

I also compared the average scores for speech discrimination, vowel production and accent production for students who had attended an immersion program with the scores of those who had not.

CHAPTER THREE: RESULTS AND DISCUSSION

3.1 Results

In this chapter I will discuss the results of the analysis of the correlation between music aptitude and second-language learning. I will also examine the effect of music training on second-language learning, and the effect of participating in an immersion program on second language learning. In addition, I will examine the factors affecting both musical aptitude and second language learning.

3.1.1 Effect of Musical Aptitude on Second-Language Learning

The results for the groups B (beginner / intermediate), C (intermediate) and D (advanced) were combined for the analyses in cases where the *r* of each group was similar to the *r* of the combined groups. This was required, since the number of students in each group was small. In Group B, 44 students participated in both the perception tests and the production tests, in Group C, 25 students participated in all the tests and in Group D, 13 students participated in all the tests.

The analysis of the correlation between music and speech for all groups combined is presented in Table 2. The results show that there is a statistically significant correlation between rhythm perception and speech perception ($r = .30$), as well as between rhythm perception and accent production ($r = .34$). A significance level $< .05$ is indicated by *, whereas a significance level $< .01$ by **. Music production showed a significant correlation with both speech perception ($r = .24$) and accent production ($r = .34$). On the other hand, tone perception did not show any significant correlation in any of the three

language tests, the speech perception tests, the vowel production (accuracy of vowel production + degree of accentedness) and the accent production, and speech production did not correlate with any of the music factors. It is to be noted that the subjects in Group B (beginner / intermediate) did not participate in the accent production test since their vocabulary was insufficient.

Table 2. Correlation between music and speech for all groups combined

	Speech Perception	Speech Production	Accent Production
Rhythm Perception	r = .30** n = 119	r = .15 n = 88	r = .34* n = 40
Tone Perception	r = .11 n = 118	r = .03 n = 87	r = .09 n = 39
Music Production	r = .24* n = 83	r = .08 n = 90	r = .34* n = 43

Note. *p < .05. **p < .01. n = numbers of students.

Most of the correlations reported in this section are weak correlations.

3.1.2 Effects of Music Training

The questionnaires (see Appendix B) completed by the students at the beginning of the perception tests were used to group the students into either the "with music training" group or the "without music training" group. A student must have played a musical instrument for at least 3 years (see p. 35), or have studied singing for the same period, to be considered as having had musical training. The average number of years the students played a musical instrument or sang in a choir was determined both for the "with music training" and the "with no music training" groups. The students with music training had an average of 11 years of either music instruction or choir practice; most of them

played more than one musical instrument, or played a musical instrument and sang in a choir. The students without music training received music tuition for an average of 1.25 years; the majority of these students took piano lessons for one or two years, or undertook no music instruction whatsoever.

The consequence of music training on the participants in the three speech tests can be seen in Figures 1, 2 and 3. In Section 1.4.3, which deals with music training and second language learning, it is stated that although there is a relationship between music training and second language learning for children (Harrison 1979), there is no such relationship for adults (Stokes 2001).

Figure 1. Comparison of means for speech perception results

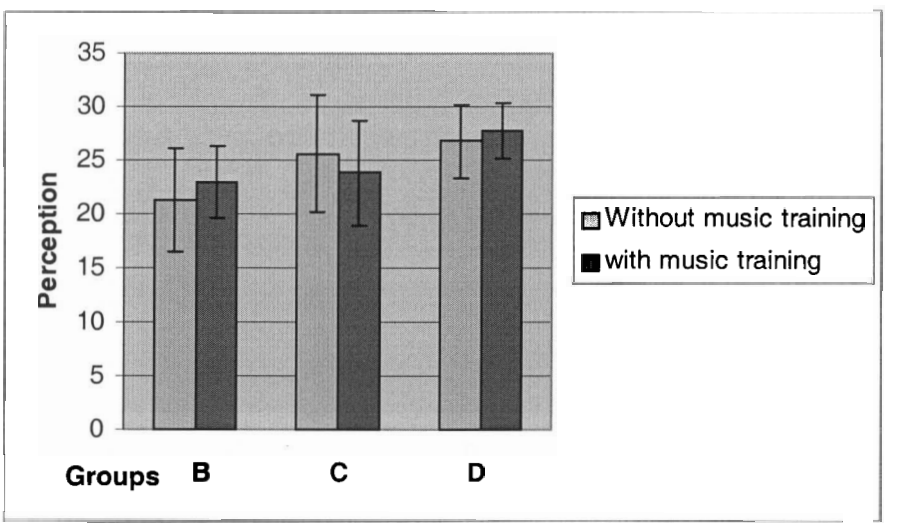


Figure 2. Comparison of means for speech production results

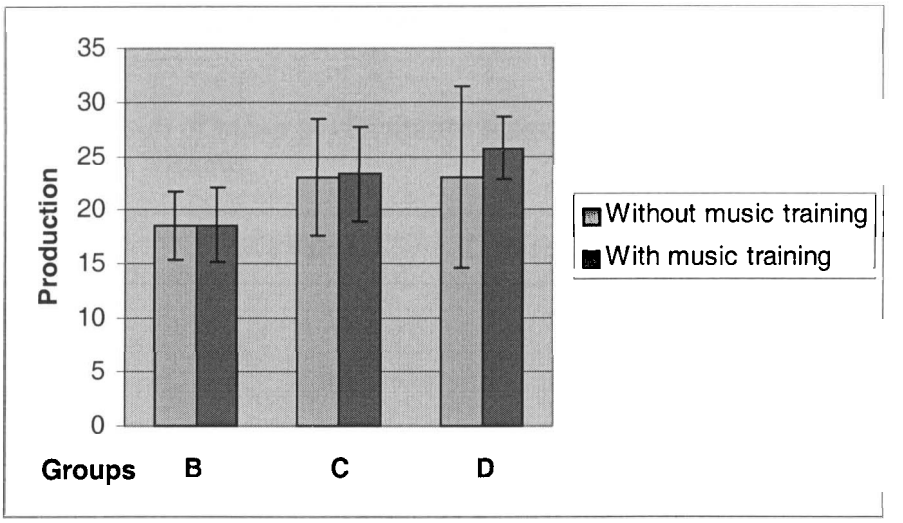
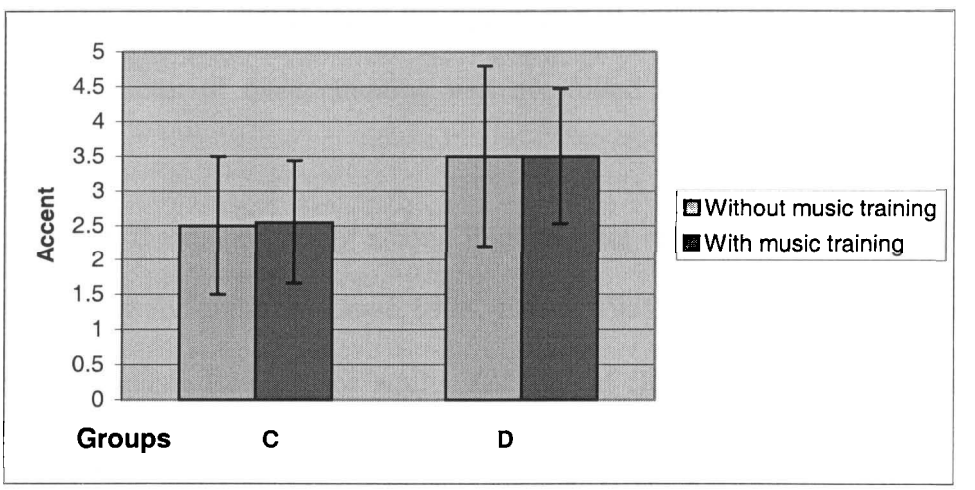


Figure 3. Comparison of means for accent production results.



The results, presented in Figures 1, 2 and 3, are in agreement with those in the literature, such as Stokes (2001), since they show no relationship between music training and second-language acquisition. I used the Student's-t-Test to compare the means of speech perception, speech production and accent production for the two groups, "with

music training" and "without music training". The values of the statistic t, the degrees of freedom and the p-value are given in Table 3.

Table 3 Comparison of mean performance scores of students with music training and those without

	t value	Degree of freedom	p value
Speech Perception	1.17	103	.25
Speech Production	1.48	82	.14
Accent Production	0.09	38	.93

Since the p-values of speech perception, speech production and accent production are greater than .05, we cannot reject the hypothesis of equality of the means. Hence, in this study, the factor of music training was not found to impact on second-language learning.

Although there is no doubt among linguists that music training supports second-language learning for children (Lowe 1998, Eterno 1961, Harrison 1979), there is also agreement that music training for adults has limited (Karimer 1984) or no influence (Stokes 2001) on second-language learning. The present experiment supports these findings.

I present in Table 4 the correlation between music and speech for the two groups combined (students with music training and students without music training).

Table 4. Relation between music and speech

	Speech Perception	Speech Production	Accent Production
Rhythm Perception	r = .30** n = 119	r = .15 n = 88	r = .34* n = 40
Tone Perception	r = .11 n = 118	r = .028 n = 87	r = .09 n = 39
Music Production	r = .24* n = 83	r = .08 n = 90	r = .34* n = 43

Note. *$p < .05$. **$p < .01$. n = number of students. (I repeat Table 2 from p.36 for clarity of discussion).

From this table we see that there is significant correlation between rhythm perception and speech perception, ($r = .30$, for $p < .05$), rhythm perception and accent production, ($r = .34$, for $p < .05$) music production and speech perception, ($r = .24$, for $p < .05$) and music production and accent production, ($r = .34$, for $p < .05$).

Table 3 show us that music training does not improve the success in second-language learning. In order to find out if music training affects the relationship between musical aptitude and second-language learning we divided the group into "students with music training" and "students without music training", and we obtain the correlation presented in Tables 5 and 6. If music training affects the relationship between musical aptitude and second-language learning, this would suggest that in further studies students with music training should be eliminated from the study or be tested separately from students who had no music training.

Table 5. Relationship between music and speech for students without musical training

	Speech Perception	Speech Production	Accent Production
Rhythm Perception	r = .41** n = 36	r = .14 n = 27	r = .76* n = 9
Tone Perception	r = .23 n = 35	r = .32 n = 26	r = .56 n = 8
Music Production	r = .44* n = 26	r = .07 n = 27	r = .80** n = 9

Note. *$p < .05$. **$p < .01$. n = number of students.

Table 6. Relationship between music and speech for students with music training

	Speech Perception	Speech Production	Accent Production
Rhythm Perception	r = .25* p = .03 n = 69	r = .13 p = .35 n = 53	r = .18 p = .33 n = 30
Tone Perception	r = .04 p = .73 n = 69	r = -.22 p = .11 n = 53	r = -.13 p = .49 n = 30
Music Production	r = .02 p = .89 n = 51	r = -.07 p = .62 n = 54	r = .21 p = .26 n = 30

Note. *$p < .05$. n = number of students.

We can observe in Table 4 a statistically significant correlation between rhythm perception and accent production, music production and speech perception, music production and accent production ($p < .05$), as well as between rhythm perception and speech perception ($p < .01$). After partitioning the students into those without music training (Table 5) and those with music training (Table 6), and repeating the correlation

analyses, we found that the correlation is substantially greater for the students without music training. As an example: for the group of students with no musical training the relationship between rhythm perception and speech perception is $r = .41$, whereas for the group of students with musical training $r = .25$. The same can be seen for the relationship between rhythm perception and accent production; for the students with no musical training $r = .76$, whereas for the students with music training $r = .18$. From the relationship between music production and speech perception I calculated the r for the group of students with no music training to be .44, whereas for students with music training it is .02. Finally, with respect to the relationship between music production and accent production, the group of students with no musical training warranted $r = .80$, whereas the group with music training received only $r = .21$.

It is important to note that for students with no musical training the correlations were significant in all the examples listed above; the p for rhythm perception and speech perception, as well as for music production and accent production, were less than .01, while for rhythm and accent production, as well as for music production and speech perception, $p < .05$. For the group of students with music training, there were no significant correlations between any of the music and speech variables with the exception of rhythm perception and speech perception. Hence, one can conclude that the relationship between music and speech is much stronger for students with no music training than for students with music training. These results suggest that although music training does not affect the means for speech perception, speech production and accent production, music training does affect both the relationship between music and speech perception and that between music and accent production.

Although the correlations between tone perception and speech given in Tables 4, 5 and 6 do not reach statistical significance, one can observe a greater correlation for students with no music training than for students with music training. For the students with music training, the speech production and accent production correlations are negative (r = -.22 and -.13 respectively), whereas for the students with no music training is positive (r = .32 and .56 respectively). The results for the correlation between tone perception and second-language acquisition for students who did not have musical training are not statistically significant.

3.1.3 Perception and Production

As expected (see discussion in Section 3.2), there is a significant correlation between speech perception and speech production; for the three groups combined, there was a statistically significant correlation between vowel discrimination and vowel production: $r = .52$ and $p < .0001$. There was also a statistically significant correlation between vowel discrimination and accent production: $r = .49$ and $p = .0015$.

This suggests that if the second-language learner has a problem in discriminating between phonemes, (s)he will tend to have difficulty in accurately producing these phonemes. Also, if the second-language learner has difficulty perceiving the difference between phonemes, according to the results presented above, (s)he will have difficulty approximating the accent of a native speaker.

3.2 Discussion

The results suggest that rhythm perception and music production are predictors for success in second-language learning. In his study of grade 6, 7 and 8 children, Eterno

(1961) has shown a correlation between rhythm perception and accent production (in Spanish); our results are in agreement with Eterno (1961) since they show that rhythm perception correlates with accent production, $r = .34$, for $p < .01$. I could not find any studies examining the relationship between music production and second-language learning; nevertheless, in the present study, music production correlates with both speech perception and accent production.

Tone perception, on the other hand, is a poor predictor of success in second-language learning, since the results of this experiment show that it correlates with none of the speech abilities. The success in speech production, in this case the production of the three vowel-contrasts studied, cannot be predicted by rhythm perception, tone perception, or music production. This is in agreement with Fish (1984), whose experiments showed no correlation between music perception and the ability to produce German phonemes.

The two hypotheses proposed in the introduction to this research have been only partially supported. The first hypothesis, which proposes a positive correlation between music perception and speech perception, has been verified solely for rhythm perception. It could not be verified for tone perception since there is no correlation between tone perception and any of the speech tests.

The second hypothesis proposed that there exists a positive correlation between music production and speech production. Speech production was then divided into two groups, speech production (vowel production) and accent production. 'Speech production' (vowel production) consisted of the production of three vowel contrasts. 'Accent production' consisted of a narrative produced by the subject and subsequently graded by a native French person who scored the production on a scale of 1-5, 1 being

completely foreign and 5 being completely native. The second hypothesis could not be verified for speech production since there was no positive correlation between any of the music tests and speech (vowel) production. On the other hand, according to this study, both rhythm perception and music production can predict success in accent production. This might open new avenues in teaching methodology since it takes into consideration both music production and speech production.

As predicted in the literature (Stokes 2001), music training did not influence the success of the students for speech perception or speech production. It would be important to apply the same tests to younger students, since the literature suggests that music training would improve such students' success when learning the pronunciation of a second language (Lowe 1998, Harrison 1979, Eterno 1961). A more refined examination of the training variable for adults might lead to other observations.

On the basis of the results presented above (p.42), music training negatively influenced the correlation between musical aptitude and second-language learning. This is further evidenced by the observation that music training does not increase success in second-language training of adults (Stokes 2001). We would expect music training to improve music perception as well as music production, and if it does so without improving speech perception and production, it is evident that the correlation between music and speech is decreased. It would therefore be important, in further studies testing the relationship between musical aptitude and second-language learning, to eliminate from the testing those students who have had music training or to provide a more refined examination of the music training variable.

The aim of the following section is to look at factors that might influence musical aptitude. If musical aptitude can predict success in second-language acquisition, is there a way to improve the musical aptitude?

3.2.1 Musical Aptitude: Nature vs. Nurture

When examining the results of this research, we become aware of an intriguing question - what is the effect, if any, of music *training* on musical *aptitude*?

If music aptitude is an innate talent, which to a large extent will differentiate between people with the same musical experience, the correlation between music and speech for students with or without music training would be expected to be the same. The results show that this is not the case, since there was no significant correlation between music and speech for students who had had music training, whereas there was a significant correlation between music and speech for students who had not undergone music training. This suggests that music training has improved the musical aptitude of the students. In the present study, informal calculation showed that students who had music training succeeded slightly better in the tone perception test (music-trained 37.7/40; not music-trained 36.6/40), slightly better in the rhythm perception test (music-trained 35.2/40; not music-trained 34.9/40) and succeeded noticeably better in the music production test (music-trained 20.4/25; not music-trained 14.7/25). Since we do not know at what age the students received their music training nor the type of music training it was, further study of the relation between music training and success in music perception and production would be necessary.

The literature agrees with this statement, since it appears that a person's success in music depends to a large extent on environment and experience.

> Research that has pursued young musicians' biographical details encourages us to consider the importance of environmental factors as being far more significant than inborn talent. (Kemp & Mills 2002, p. 6)

It has also been suggested that two people from exactly the same environment and experience will not necessarily achieve the same success, since there is a portion of innate talent that will play a role in this achievement.

> Thus an innate component is clearly featured in musical ability. Most researchers (e.g., Gordon, 1986) agree that the development of musical abilities is based on the interaction between innate capacities and environment. Depending on environmental conditions, the relative importance of innate differences changes. (Kemp & Mills 2002, p. 18)

Meyer-Denkmann (1977) suggests that musical aptitude is a mixture of both innate talent and environment.

> Psychology tells us that intellectual development depends on inherited talents plus environmental and educational conditions. That is to say, how a child is gifted depends not only on 'natural talent', but also on the kind of stimulation a child gets or does not get from his environment, and the experiences he has as a member of a family, which is itself a part of a particular society in which he grows up. These stimulations may be positive or negative. (Meyer-Denkmann 1977, p. 1)

This innate component of musical ability can be difficult to separate from environment influence. A child singing at a young age might sing because people sing in the family. A musical family might not only have a genetic predisposition for music but also encourage a child to play a musical instrument or sing.

> Musical potential is something that all children have, although arguably some may have more of it than others, and musical potential may come in different shapes and forms. Musical behavior such as joining in singing means that a child has responded favorably to an opportunity to learn music but does not necessarily mean that a child has more potential for music than any other child. Neither does it necessarily mean that the child will show more aptitude if offered that chance to learn an instrument, that

> is, that he or she will realize the potential to develop the ability to play it effectively more speedily than any other child. (Kemp & Mills 2002, p. 4)

Kemp & Mills (2002) also suggest that musical talent might not only be reinforced by family encouragement and motivation, but also by an introvert personality, which would help a child to focus on music training.

> Research into the personalities of talented musicians suggests that they have a distinct pattern all their own and that this pattern, if not fully in place in young musicians, is well on the way to being developed... However, it must be emphasized that the musician's form of introversion takes a slightly different nature from that normally found in general populations, simply because it does not involve the usual element of shyness. The most prevalent aspect of the young musician's introversion is a significant level of self-sufficiency coupled with an element of aloofness or detachment particularly located in the very talented. (Kemp & Mills 2002, p. 5)

Such young people would not suffer unduly from the isolation brought about by the study of music. Introvert children might also be attracted towards such personal activities as music and other creative work.

Gordon (1979) states that music training influences musical aptitude until the age of nine. Chouard (2001), while talking about the brain, explains that a part of the brain is larger for musicians if music training began before the age of seven.

> ...le corps calleux. Il s'agit d'un volumineux faisceau d'association interhémisphérique. Sa partie antérieure est significativement plus large chez les musiciens mais seulement chez ceux qui ont débuté l'apprentissage de la musique avant l'âge de sept ans. (Chouard 2001, p. 224)

3.2.2 Influences on Musical Aptitude

3.2.2.1 Perfect Pitch

Perfect Pitch or Absolute Pitch is "the ability to precisely recognise musical notes" (Saffran 2001) without hearing another note that would act as a reference. People who have a relative pitch, on the other hand, can only identify a note in relation to another pitch. It is believed that only one in 10, 000 people possesses perfect (or absolute) pitch (Hall 1999; Abrams 2001).

Saffran (2001) suggests that everyone is born with perfect pitch, but that this perfect pitch is lost for most people because it is not useful in ordinary life. She also states that perfect pitch helps babies learn to speak, and that when speech is acquired, perfect pitch is lost if the child is not trained for music.

Saffran (2001) tested eight-month-old babies, with a test similar to the head-turn test for linguistics. By playing the same series of notes a few times and then changing to a slightly different series of notes she could get the attention of the babies. This shows that babies discriminate between the series. The adults tested by Saffran, on the other hand, could not tell the difference.

3.2.2.4 Influence of Language on Musical Aptitude

Researchers, for example Saffran (2001), have suggested that perfect pitch is not completely innate, but that a talent from birth, combined with an appropriate environment, could allow a person to have perfect pitch. A study by Deutsch (1994) showed that, while music training, musical environment and attitude can influence the acquisition of perfect pitch, linguistic environment may also contribute. According to Deutsch, speakers of tone languages need perfect pitch in order to communicate in these

languages. Deutsch shares the belief of Saffran (2001) that everyone is born with perfect pitch and that if you don't use your perfect pitch you will lose this talent; speaking Mandarin or Vietnamese, according to Deutsch, allows children to use their perfect pitch and therefore to keep it into adulthood.

Chouard (2001) shares with Deutsch this notion that perfect pitch and linguistic environment are closely related:

> On a observé que les sons purs donnent, dans l'aire auditive gauche, des réponses cérébrales d'autant plus amples que la langue maternelle des sujets testés comporte davantage de voyelles de structure fréquentielle complexe. Cela incite à se demander si le don des langues n'a pas une origine comparable à celle de l'oreille absolue. Il se retrouve chez tous les peuples, mais il est plus développé chez les Russes et les Hongrois, dont la langue maternelle implique la distinction de variations fréquentielles particulièrement subtiles. (Chouard 2001, p. 264)

> ...20% des musiciens professionnels semblent dotés de l'oreille absolue. D'autres études quantitatives proposent des pourcentages du même ordre, ou un peu plus importante chez les Asiatiques, sans préciser leur langue maternelle. (Chouard 2001, p. 264)

3.2.3 Differences in Second-Language Learning Aptitude

The influence of musical aptitude as well as music training on second-language learning has been investigated in this study. However, it is obvious that many other factors might come into effect when learning a second language. Although it was attempted to eliminate some factors from this study, some others remained. In the following section, I will take a look at factors that might have influenced the results of the present study.

In an attempt to explain the individual differences between students learning a second language, we will observe different factors influencing the learner. Major (2001) lists a number of personality factors such as empathy, motivation, sense of identity, ego

permeability, self-esteem, risk taking, anxiety, introversion, musicality, and field independence, together with such sociolinguistic factors as geography, style, profession, ethnicity, age, social class, and gender.

One can appreciate that there are differences in the rate and success with which a second language can be acquired. Fillmore (1979) shows that even for children, the ways in which they acquire a second language will vary greatly. To demonstrate this, she paired five monolingual Mexican children, recently arrived in the United States and aged between five and seven, to five monolingual children native speakers of American-English of the same age group. She noticed the attitude of the child made a great difference in the learning of English. The youngest one, a little girl, played only with English-speaking children and engaged in many verbal activities, whereas the eldest boy played only with Spanish speakers. The English boy he was paired with was the only bilingual child in the program and was used in the study only because the Mexican boy refused to communicate with English speakers. The little girl was very successful in learning English, while the little boy had great difficulty. Fillmore's study is very important since it shows that large differences exist in the process of learning a second language, even for young children. It would be of great interest to determine the reasons, if any, for these differences. The participants in this study were two girls and three boys. The two girls were the youngest. The two eldest were boys who had already had a year of school in Mexico. Could gender have influenced this test? Fillmore explained that the boys talked very little during their activities, using only the minimum language necessary to play sports, whereas the girls engaged in many verbal activities. The younger girl liked to create plays that she would act out with her English friends. The other girl liked to talk

with the teachers. The factors of sex, age of learning, attitude towards the language, all seem to play a role in Fillmore's study. Although musical aptitude appears to have some influence on second-language acquisition, according to Fillmore (1979), the attitude towards a second language might have an even greater influence.

Major (2001) explains that there is an Interlanguage, 'an adult second language learner's linguistic system', which is not a cluster of random mistakes but rather predictable substitutions due to the interference of L1. "Negative transfer occurs when L1 and L2 phenomena are different, resulting in errors"(p.63). Some substitutions are considered universal if they are made by children learning this language as L1, or if speakers of different L1 make the same errors in L2, even though these errors cannot be explained by their L1. The interlanguage is therefore constituted of L1, L2 and universals. In our study, although the first language was English for most, there were several participants with Chinese or Indian language background.

3.2.3.1 Effect of Immersion Classes on Second-Language Learning

There has been much controversy regarding the effectiveness of French Immersion classes. Hammerly (1989) has spoken about fossilization of errors (errors that, once part of the student's language acquisition, will be very difficult to correct) and other problems related to immersion programs. He also criticizes the immersion programs for suggesting that children should learn a second language in the same manner as a child would learn a native language.

> The second language teaching of linguistic adults should not imitate the way children acquire their native language, for, despite the general similarities between the two processes, there are many fundamental differences, and such imitation would result in a tremendous loss of efficiency. (Hammerly 1982, p. 102)

It is nevertheless noticeable in most French classes that students from immersion classes, despite being very weak in French grammar, manifest an evident facility for conversation that causes other students to become quite uncomfortable in their presence. In several conversation classes, the author has observed the conversational advantage of students from immersion programs.

Several studies show that, as a tool for developing conversational skills, immersion programs are superior to the conventional teaching of French as a second language.

> The research presented here suggests that immersion programs have been successful at producing learners who are able to negotiate meaning in a target language. (Kinberg 2001, p. 42)

Conversely, other researches have shown that immersion students, although superior in the target language to students in regular programs, were inferior in accuracy to native students.

> Malgré l'enthousiasme de l'équipe de Lambert et Tucker (1972), on s'accorde, en effet pour reconnaître que les capacités productives des élèves de l'immersion n'atteignent pas celles des locuteurs natifs, mais qu'elles dépassent celles des élèves ayant appris le français dans des programmes traditionnels. (Rebuffot 1993, p. 110)

The effect of immersion classes on the perception and production of French can be seen in Table 7. It is to be noted that only students who were in immersion classes for three years or more were considered as having followed an immersion program. There appears to be a natural division between students who had not attended an immersion school, or had attended for one year only, and students who had followed an immersion program throughout their elementary schooling.

Table 7. Descriptive statistics for immersion classes on Speech

Variable	Group	*n*	Mean	Standard error
Speech Perception	Immersion	24	26.3	0.72
	No immersion	95	23.1	0.47
Speech Production	Immersion	21	24.8	0.92
	No immersion	67	20.6	0.53
Accent Production	Immersion	14	3.4	0.29
	No immersion	26	2.6	0.18

To compare the means of the two groups, immersion and non-immersion, I used the Student's-*t*-Test. The value of the statistic *t*, the degrees of freedom, and the *p*-value are given in Table 8.

Table 8. Results of the Student's-t-test

	t Value	Degrees of freedom	*p* value
Speech Perception	3.23	117	.0016
Speech Production	3.93	86	.0002
Accent Production	2.54	38	.0155

Since, for each of the speech perception and production results the *p* value is less than .05, the hypothesis of equality of the means must be rejected. There is thus a

significant difference between the results of students who followed the immersion program and those who did not.

The results presented above clearly indicate that students who had previously attended an immersion program, when placed in a group with non-immersion students of the same grammatical level, will tend to achieve greater success for perception, phoneme production and accent production than the non-immersion students.

3.2.3.2 Age of Learning

Do children learn a second language faster, or with more accuracy, than adults? Most authors and teachers seem to agree that children have more facility than adults, especially where pronunciation is concerned. When those changes in learning ability take place is still a subject of controversy.

Several studies, such as those of Werker & Polka (1993) and Kuhl (1992), explain that young infants up to six months of age discriminate most, if not all, of the phonetic contrasts in any language.

Between eight and ten months of age there seems to be a reorganization in this ability, causing a consistent decrease in the faculty of infants to discriminate non-native contrasts. Interestingly, if these contrasts are assimilable to native contrasts, this group of infants will do poorly, whereas adults will do quite well. (Werker & Polka 1993) In our study, most students had started learning French either as teenagers or as adults.

Although infants eight to ten months of age might do worse than adults in a perception test, it is not to say that they will be worse at learning a second language. It has been shown that adults have difficulty discriminating non-native contrasts.(Werker & Polka 1993) Some contrasts are more difficult than others to perceive (Logan 1991), and

even in the case of easier contrasts, non-native adults will still have the tendency to be outperformed by native speakers.

The age beyond which a L2 learner cannot, even with training, become as proficient in this L2 as a native speaker, has been called the Critical Period or Sensitive Period. There appears to be a discrepancy between linguists as to what age coincides with this critical period, and even whether there is a critical period.

According to Long (1990), there is no clear-cut age at which deterioration of linguistic capacity occurs; it occurs gradually, and for some people this deterioration can begin as early as six years of age. It has been suggested frequently that this critical period occurs at puberty (Lennenbeg 1967).

In their studies on Japanese protestant missionaries (see pp. 16-18) Jacobsen & Imhoof (1974) show that learning a second language during childhood is an advantage for learning a third language during adulthood.

> A bilingual adult who spoke two languages as a child has developed a "switch mechanism" – conditioning that enables him to turn from one language to another without confusion, translation or accent. (Jacobsen & Imhoof 1974, p. 330)

3.2.3.3 The Right-Ear Advantage

Information received by the right ear goes directly to the left hemisphere (left-brain), which puts the sound into language. People who are left-ear listeners have the disadvantage of having the sound sent to the right-brain and subsequently, by passing over the corpus callosum, to the left brain, where it is transformed into language. (Major 2001; Tomatis 1991) Right-ear listeners, the most common, will therefore have a distinct advantage for learning a second language, since they process the information more quickly and more completely than left-ear listeners.

Tomatis (1991) explains how for the majority of people, the right ear prevails for listening to music. In a test, Tomatis asked a professional singer to listen to tunes and sing what he heard. When wearing a headset blocking the left ear, the singer had no problem repeating the tunes; his singing appeared, both to the singer and Tomatis, to be more accurate than when listening with both ears.

> Les sons émis semblaient, pour une oreille très avertie, plus légers, plus aériens, plus modulés, plus précis, plus détachés, d'un legato plus parfait. (Tomatis 1991, p. 109)

When the right ear was blocked, leaving only the left ear for listening, the quality of the singing became very poor.

> ...par contre, lorsque nous inversions notre système de contrôle et que nous le mettions sur l'oreille gauche en éliminant l'oreille droite, non seulement cette facilité extraordinaire s'effondrait mais, au surplus, toutes les qualités professionnelles acquises par le chanteur s'évanouissaient... La voix devenait lourde, grossière, ternissait... (Tomatis 1991, p. 111)

Tomatis (1991), after testing a professional singer for the singing voice, tested an actor for the spoken voice. Similarly to the test for the professional singer, the actor had to repeat several sentences. First the actor listened with both ears, then with the right ear only. Like the singer, when the actor listened with the right ear only, the tone of his voice improved.

> Lors de la suppression de l'oreille gauche, la voix devint plus légère, plus timbrée, plus haute. Le fait était ici d'autant plus remarquable que notre comédien était doté d'une voix très grave. (Tomatis 1991, p. 113)

On the other hand, when listening with the left ear, the voice became flat and hesitant.

> Par contre, lorsque l'élimination porta sur l'oreille droite, ce fut une vraie déconfiture. Il ne restait plus chez notre comédien qu'une voix blanche,

> sans timbre, mal conduite, qui très rapidement laissa s'introduire des hésitations, des «euh» de plus en plus prolongés, puis, au bout de quelques phrases, ce bredouillement s'entrecoupa de redoublement syllabique, de blocage, aboutissant à notre étonnement à un bégaiement caractéristique. (Tomatis 1991, p. 113)

Our study shows that musical aptitude is a factor influencing the learning of a second language. Nevertheless, other factors may also have to be taken into consideration when accounting for the success with which someone will acquire a second language. I have made an attempt to eliminate most of these factors from our study. However, it was not possible to discard all variables (see pp. 71-72) that might alter the results of this study (for example, not all the students started learning French at the same age, some of the participants were males and some might not have the right ear advantage).

3.2.4 Perception and Production

Researchers such as Tomatis (1991) claim that perception is the basis for production and that most problems in production are caused by faulty perception of different phonemes in the L2. Others assert that most mistakes in production are due to a difficulty in imitating the L2, even if the perception of L2 phonemes is accurate (Purcel & Suter 1981). Studies such as Best (1994), and Burham (1986) show that the type of contrast will have a great influence on the perception and production of L2 phonemes.

The results of our study show that there is a correlation between speech perception and speech production; this suggests that perception influences production and that speech perceptual training might in turn improve speech production. Further details on this correlation will be discussed in Section 3.2.4.2.

3.2.4.1 Perceptual Models

The Perceptual Assimilation Model (Best, 1994) predicts that if L2 phonemes are perceived as two different L1 phonemes (TC – Two Categories discrimination), the discrimination of the two L2 phonemes will be good. As well, if two L2 phonemes are perceived as belonging to a single L1 category, and one of these phonemes is perceived as identical to L1 phonemes, while the other is considered a poor representation of the same phoneme (CG – Category Goodness discrimination), the discrimination of the two phonemes will be good. Discrimination is also good in the case of L2 phonemes that are so different from any L1 phonemes that they would not even be perceived as speech sounds (NA – Non-Assimilable). Finally, when two L2 phonemes are perceived as belonging to a single L1 category, the perception of these two L2 phonemes will be quite poor.

It has also been suggested that L2 contrasts are not only perceived in relation to L1 contrasts but in relation to the type of contrasts. According to Burnham (1986) some contrasts are fragile, which signifies that they are used by few languages and are rather easy to lose when not exposed to L2. On the other hand, robust contrasts are common in the world's languages and are easier to retain. The acquisition of the fragile contrasts would therefore entail much training and could be lost at the end of the learning process, whereas the robust contrasts would need less training and would have a greater tendency to be maintained.

In Morgan-Carter (1998), these different theories were considered in the investigating of the perception and production of French vowel contrasts [y/u], [ã/õ] and [e/ɛ]. The results showed that the contrast [u/y] is robust (Burnham 1986) since both beginner, intermediate and advanced students had a facility for discriminating and

perceiving these contrasts. French [y] and [u] might be so different from each other that little training would be necessary to acquire their perception and production. In this study [ã/õ] follows the prediction of Two Category discrimination (Best 1994), but would be more difficult to perceive and produce, due to nasality. The [e/ɛ] contrast appears to be very difficult to discriminate and to produce. This is rather surprising, because there are two pre-existing categories in English, [ej] and [ɛ]. There are two possible explanations. The first is that the cue for the recognition of English [ej] might be the diphthong and, without it, the monophtong [e] might be perceived as [ɛ]. The other possibility is phonotactic; English [ej] can occur in open and closed syllables, whereas English [ɛ] can occur only in closed syllables.

3.2.4.2 Perception versus Production

Contrastive analysis of second-language acquisition states that where there is a difference between L1 and L2 there will be a problem in the perception and production of these differences. Many authors suggest that this view of interference might be too simplified. Rochet (1995) stated that two sounds might be described as identical, while phonetically they represent different identities. In his study, Rochet tried to determine if accented speech was due to faulty production or faulty perception in L2, or to both. His study first observed Brazilian Portuguese and Canadian English in their production of the French high front vowel [y], which is often pronounced by Portuguese as an [i]-like vowel and by English speakers as a [u]-like vowel. Since both Portuguese and English languages contain the vowels [i] and [u], why does the former choose [i] and the latter [u] in their imitation? According to Rochet, the problem might not be articulatory, since 52% of the Portuguese and 51% of the English can produce an [y]-like vowel. Rochet's

experiment showed that in early stages of L2 learning, students perceive the sounds of the L2 language according to rules of categorization in their L1. The vowels [i] and [u] are perceived differently by English and Portuguese and therefore their perception and production of [y] will fall at a different point of their high-vowel continuum.

Graham (1969) explains that the most important ability needed to learn a second language is perceptiveness and the second most important is the ability to imitate. Although it is relatively simple with training to "recognize the music of the foreign language" (p.447), it is quite difficult to imitate this music.

Purcell & Suter (1981) analyzed the results obtained by Suter (1976) in an investigation to find a predictor for success in English pronunciation. In their study, there were 20 predictor variables, including age of arrival, time spent learning the language, sex, social and emotional factors and the subject's aptitude for oral mimicry. They identified four factors that are important predictors of success for a student of English as a second language: mother tongue, aptitude for oral mimicry, residency, and strength of concern for pronunciation accuracy.

Kohler (1981) also suggests that acquisition of L2 production is far more difficult than perceptual acquisition. He describes how German listeners succeeded quite well in French perception tests and improved rapidly with systematic training, whereas they were far less successful with the production of the corresponding contrasts.

The Tomatis method is based on the theory that you cannot produce what you cannot hear, and that training can improve your capacity for hearing the sounds of a second language and consequently ameliorate production in this second language. The three laws of Tomatis are as follows:

1. "La voix ne contient que ce que l'oreille entend... Le larynx n'émet que les harmoniques que l'oreille peut entendre."

2. "Si l'on rend à l'oreille lésée la possibilité d'entendre correctement les fréquences perdues ou compromises, celles-ci sont instantanément et inconsciemment restituées dans l'émission vocale."

3. "La stimulation auditive entretenue pendant un temps déterminé modifie, par un phénomène de remnance, la posture d'auto-écoute du sujet, et par voie de conséquence, sa phonation. (Tomatis 1991: 210-211)

The results of the present study show a correlation between speech perception (vowel discrimination) and speech production (both vowel production and accent production). Although it is believed that perceiving a sound accurately will help in producing this sound correctly, it is also supposed that some sounds that can be produced correctly may not be perceived accurately; the distinction between the [r] and the [l] by Japanese speakers (Flege et al. 1995) may be an example of this. Some participants will have great difficulty discriminating between these two phonemes, nevertheless will be able to produce them distinctively.

On the other hand, it has also been observed by the author that students who can perceive some phonemes accurately might have great difficulty in producing them. An example of this is the French uvular trill [R], which gives a lot of difficulty to students at the production level, even though it is very easy to perceive.

The relationship between musical aptitude and second-language acquisition broaches some interesting topics, such as the fact that the acquisition of both music and language can be influenced by handedness, by sex, by mother tongue and by the age at which learning began. These similarities between musical aptitude and second-language acquisition suggest that a better understanding of their relationship might help to better understand how to teach them.

CHAPTER FOUR: CONCLUSION AND IMPLICATIONS

4.1 Conclusion

In this study, the objective was to investigate whether differences in musical aptitude was the reason why some students learn the pronunciation of a second language easily whereas other students struggle while learning a second language and achieve little success. The experiment described in Chapter 2 was aimed at determining if there is a relationship between musical aptitude and second-language acquisition. Students from the department of French of Simon Fraser University took part in four tests, two for musical aptitude, perception and production, and two for speech, perception and production. The music perception test was a same/different task for both tone and rhythm. For the music production test, the students listened to a musical note and tried to reproduce it. For the speech perception test, the students performed a forced choice task for three vowel contrasts. The speech production test was divided into two tasks. For the first one, the student read a list of words containing the same three vowel contrasts as in the speech perception test. For the second task, the advanced students recorded themselves talking about their morning activities. The students' performances were subsequently analyzed by native speakers of French for the speech test and a graduate student from the department of music of Laval University for the music tests. After completion of the statistical analysis it became apparent that there is a significant correlation between rhythm perception and speech perception and between rhythm perception and accent production; there is also a significant correlation between music production and speech perception and between music production and accent production.

On the other hand, tone perception was a poor predictor for both speech perception and production. These findings partially confirm the hypotheses presented at the onset of our study. The first hypothesis stated that there is a positive correlation between music perception and speech perception. This has been verified for rhythm perception but not for tone perception, although, as stated in the results section (section 3.1.2), I believe that if the students had all been musically naïve, we might have found a correlation between tone perception and speech perception. The second hypothesis stated that there is a positive correlation between music production and speech production. Once again this has been partially verified since there is a significant correlation between music production and accent production, whereas there is no significant correlation between music production and the production of the three vowel contrasts.

On the basis of the observed correlations it has to be recognized that (i) music training does not influence success in vowel perception, vowel production and accent production, and (ii) music training influences the relationship between musical aptitude and second language learning.

Further, the results show that students who attended an immersion program in elementary school and/or in high school performed significantly better in tasks consisting of vowel discrimination, vowel production and accent production.

4.2 Implications of Research Results for Second-Language Teaching

The above-summarized findings have significant implications for second language teaching methodology. What follows is a list of suggestions, the implementation of which may prove beneficial for teachers of second-language classes.

4.2.1 Some Recommendations Concerning the Role of Musical Aptitude in Classroom Practice

The results found in this research could prove to be of great interest for language teaching methodology, since they show that there is indeed a correlation between musical aptitude and second-language learning. With the benefit of rhythm perception and music production tests, teachers will be able to place students in two groups, and create a more appropriate curriculum for the students, that is, students with musical aptitude will comprise one of the groups, and those without musical aptitude the second.

The author recommends that rhythm perception and music production tests be used to assess students prior to language learning, since the results of these tests will give the teachers the possibility to evaluate and group the students and to subsequently create an appropriate learning program for each group. Some suggestions on the basis of the results of this study are presented below with regard to classroom practice:

- Special tests should be created for students who have had music training since, in their case, there is no direct relationship between their musical ability and their aptitude for learning the pronunciation of a second language.

- The students should be separated into two groups; should a more complete curriculum be available, the number of groups could be extended. The first group will consist of students with above average musical ability, and the second group will consist of students with under average musical ability; this average ability will have to be determined from the analysis of the results of testing using either the Gordon Musical Aptitude Profile (Fish 1984), the Conn Musical Aptitude test (Eterno 1961), or the Seashore Measures of musical talents (Leutenegger & Mueller 1964)

- The lessons for the first group of students, the students with music ability, will include a strong music component, such as the CMA (Anton 1990), which includes listening to songs, vocabulary search, listening exercises, singing, and writing of lyrics in the second language. Since the students

from this group already have an auditory advantage, they will be able to learn the pronunciation of a second language with less difficulty.

- On the other hand, students with under-average music ability must follow a completely different pronunciation program. This program will still include a modest music practice, since we have seen that music encourages relaxation, auditory development, motivation and cultural awareness (see section 1.3.2). The principal section of this program will, nevertheless, include the study of sound production, contrastive phonetics and extensive transcription in the new language, so as to encourage phoneme discrimination.

- The first section of the pronunciation program should be an introduction to phonetic symbols and articulatory phonetic theory. This introduction will give the students the necessary tools for learning, and correcting themselves, during the whole acquisition process of their second language, and during any subsequent acquisition of other languages.

- The first section of the pronunciation program will last an average of a month if the pronunciation classes are held twice a week. The second section of the pronunciation program for students with little musical ability, will involve phonetic transcriptions to assess and correct their phoneme discrimination. Although the traditional phonetics laboratory might be very useful for some students, it might be a waste of time for this group of students, since they have great difficulty discerning whether or not what they heard is accurate. The use of the language lab might even reinforce their errors, since they would repeat the same mistakes over long periods. Phonetic transcriptions will help the students visualize their perceptual errors, which in turn will help them correct production errors.

- With the aid of phonetic transcriptions and the support of one-on-one lab instructors, the students will be able to start the production phase. These lab instructors will assist by listening to the students and providing oral suggestions and corrections. The students will also record their own voices while reading words or sentences. These short recordings will subsequently be phonetically transcribed by the lab instructors, and used as a tool for understanding the problem areas of the students and assisting them to correct their errors.

- The fourth section will involve suprasegmentals, for which the lab instructors will need to possess advanced listening skills so that they may listen to the recordings of the students and schematically represent the inaccurate elements.

- It is to be noted that the remaining three or four hours a week of classes might retain the curriculum of traditional language classes: reading texts, grammar explanations, repetitions, drills, written exercises, compositions,

> conversations, role play and so forth This musical/non-musical approach provides further motivation for musically-endowed students, and a relief from frustration for musically-challenged students, who continuously hear and repeat the same mistakes without having the tools to improve.

It is obvious that more research will have to be made on this topic before applying such a method, but this research has shown that such a method may prove to be beneficial.

4.3 Outlook for Future Research

A study of the following subjects may help to better understand the relationship between music and language.

4.3.1 Music Training

I found no correlation between music training and second-language acquisition for adults. Nevertheless, it might be too early to extend this generalization to all musical instruments, since the playing of some instruments might have a different relationship with language than others. A more instrument-specific questionnaire would therefore be provided to the students during later testing. It would also be important to observe the relationship between singing and language acquisition, since for speech and second-language learning, singing might have a greater effect than the playing of a musical instrument. A clarification of how long a subject should play a musical instrument, or for how long a subject should practice singing, in order to produce an effect on his/her second language acquisition, might prove to be useful; it would also be relevant to establish whether famous singers have a second-language-learning advantage. A more

refined questionnaire might allow for a better examination of this relation between music training and second language learning.

4.3.2 Languages

From our study we observed the relationship between musical aptitude and second-language learning, the language in this experiment being French. As stated in the introduction, Jacobsen & Imhoof (1974) concluded that there was no correlation between pitch discrimination and the acquisition of Japanese, and suggested that pitch discrimination might not be as significant a factor for all languages. It would therefore be useful to pursue our study by examining both the correlation between musical aptitude and ability to learn different types of languages, such as tone languages, and the correlation between musical aptitude and ability to learn a third or fourth language.

4.3.3 Age

In the literature related to music and language acquisition, the results for children are different from those for adults. None of these studies described in the literature has compared the achievement of children and adults, even though we could expect a noticeable difference, since: "music aptitude does not continue to develop after a child is about nine years old. It stabilizes: the level of aptitude the child acquires by age nine remains ostensibly the same throughout life" (Gordon 1979, p. 4). It would therefore be enlightening to compare, for both children and adults, the relationship between second-language learning and music in the classroom, between second-language learning and music training, and between second-language learning and musical aptitude; this

should be repeated for children of different ages, to ascertain at what ages the correlations are strongest.

4.3.4 Learning Strategies

It is suggested in the conclusion of this research that musical students would benefit from a music-oriented program, whereas non-musical students would benefit from a phonetic transcription program. This suggests the question: "Is there a relationship between being musically deficient and being a visual learner, and a relationship between being musically adequate and being an auditory learner?" The relationship between music aptitude and learning strategies is therefore a topic that could bring some insight into teaching methodologies.

In the same direction, the topic of brain laterality[9] would be of great interest for research on the advantages of a language program adapted for different learning styles.

4.3.5 More Phonetic Questions

I would also like to observe different aspects of second-language acquisition. In the present experiment, I have taken in consideration vowel perception, vowel production and accent production; in the future we would suggest studying the relation between musical aptitude and VOT, vowel lengths and stress patterns.

I do not believe that it will be possible to find a solution for rapidly learning a second language. Nevertheless, it is my goal to find the most efficient methodology for learning second language pronunciation that would take into consideration the individual differences between students, thus making the acquisition of a second language a more effective, enjoyable and less frustrating experience.

4.4 Limits of the Study

There are two important factors that need to be mentioned here in terms of their effect on the outcome of this research.

The first one refers to the experiment itself. Unexpectedly, the greatest problem of this study, involving two hundred participants, was the small number of participants available for individual tests. There remained only 92 participants for the production tests, since more than half of the participants who took the perception tests did not attend the production tests, and some of the participants who took the pronunciation tests were not present for the perception tests. Some of those who presented themselves for the production tests were in such small numbers per group (three in French Group A, four in Group E) that their production extracts had to be discarded. Those who were left were divided in five groups; some of the correlations from these groups were analyzed with N of 40 and others with N of 11.

Because of the small number of students in each group, I decided to study the results of the three groups, B, C, and D, as one single group. This is viable, since the correlation results for each group individually are very similar.

The small number of participants in each group prevented us from eliminating variables such as sex, age, L1 and immersion (participating in an immersion program). Further studies might allow us to eliminate some of these variables.

The second factor affecting the evaluation of the results of the experiment is the scarcity of available research on the relationship between musical aptitude and the learning of French as a second language (see p.22-23). Thus, because our study cannot be related to previous research in this respect, the validity of the results awaits to be

confirmed by repeating the experiment, thereby providing independent evidence for the support of the findings in this study.

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APPENDIX A: CONSENT FORM

FORM #2

SIMON FRASER UNIVERSITY

INFORMED CONSENT BY SUBJECTS TO PARTICIPATE IN A RESEARCH PROJECT OR EXPERIMENT

The University and those conducting this project subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects. This form and the information it contains are given to you for your own protection and full understanding of the procedures. Your signature on this form will signify that you have received a document which describes the procedures, possible risks, and benefits of this research project, that you have received an adequate opportunity to consider the information in the document, and that you voluntarily agree to participate in the project.

Any information that is obtained during this study will be kept confidential to the full extent permitted by law. Knowledge of your identity is not required. You will not be required to write your name or any other identifying
information on the research materials. Materials will be held in a secure location and will be destroyed after the completion of the study. However, it is possible that, as a result of legal action, the researcher may be required to divulge information obtained in the course of this research to a court or other legal body.

Having been asked by Caroline Morgan of the Linguistics Dept.of Simon Fraser University to participate in a research project experiment, I have read the procedures specified in the document.

I understand the procedures to be used in this experiment and the personal risks to me in taking part.

I understand that I may withdraw my participation in this experiment at any time

I understand that my participation in this experiment is on voluntary bases

I also understand that I may register any complaint I might have about the experiment with the researcher named above or with Chair of the Linguistics Dept. of Simon Fraser University.

I may obtain copies of the results of this study, upon its completion, by contacting: Caroline Morgan

I have been informed that the research material will be held confidential by the Principal Investigator

I agree to participate by
1) Listening to a recording of musical notes and writing if they are the same or different.
2) Listening to a recording of three lists of 10 French words and placing a check mark under one of the two vowels heard.
3) Being recorded reading three lists of 10 French words
4) Being recorded repeating five musical notes.

as described in the document referred to above, during the time period at Simon Fraser University.

NAME (please type or print legibly): _____

ADDRESS: _____

_____

SIGNATURE: _____ **WITNESS:** _____

DATE

ONCE SIGNED, A COPY OF THIS CONSENT FORM AND A SUBJECT FEEDBACK FORM SHOULD BE PROVIDED TO THE SUBJECT.

APPENDIX B: QUESTIONNAIRE

QUESTIONNAIRE

Please answer the following questions and do not hesitate to ask for help from the test administrator. Answering these questions is on a voluntary basis and all the information will be kept confidential.

Date: _____

Name: _____

Phone and/or e-mail: _____

French classes taken: _____
(at present and in the past)

Immersion: _____

Language(s) spoken: _____
(Underline mother tongue)

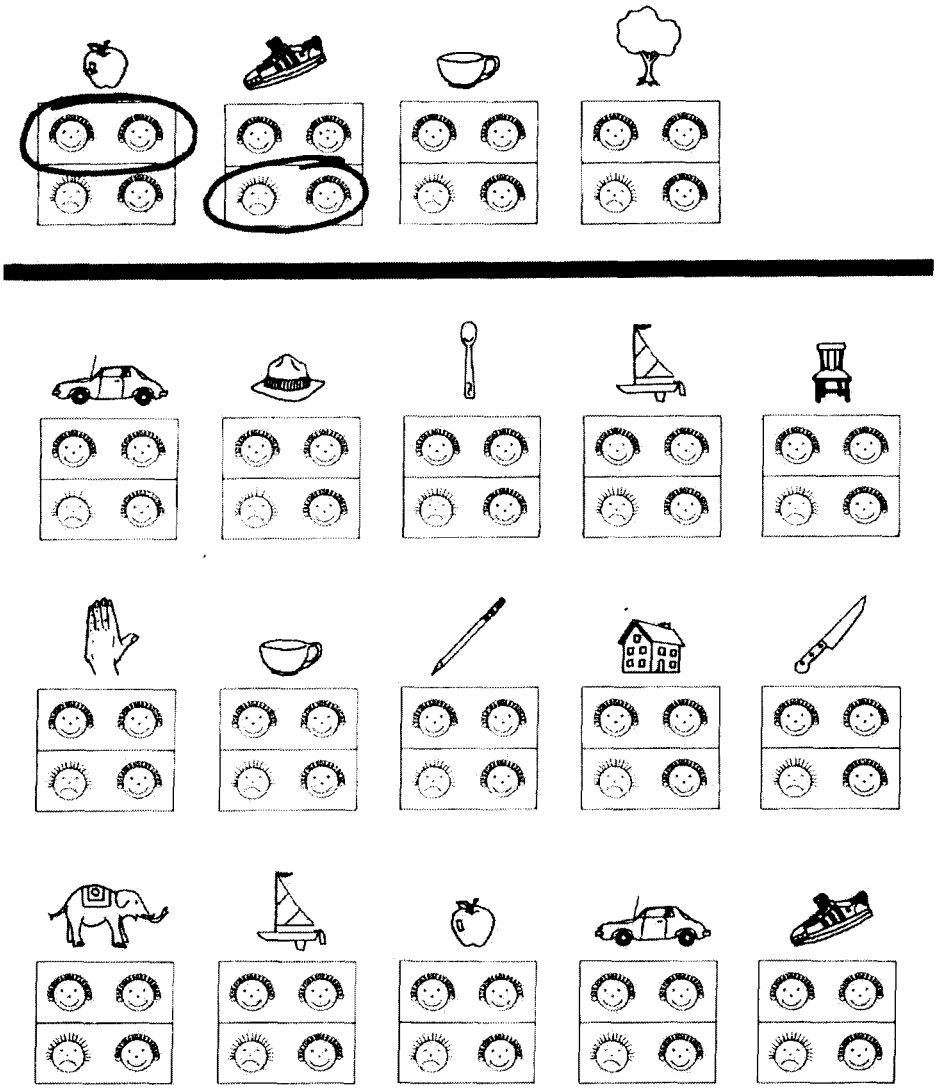
Time spent in French environment: _____
(Where, when and how long)

Music history: _____
(Instrument played, how many years...)

Thank you very much,
C. Morgan

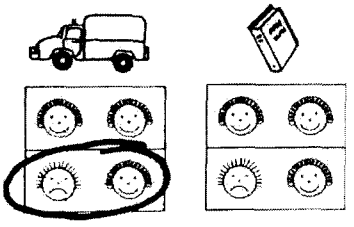
APPENDIX C: GORDON'S INTERMEDIATE MEASURE OF MUSIC AUDIATION'S ANSWER SHEET FOR CHILDREN TONE TEST

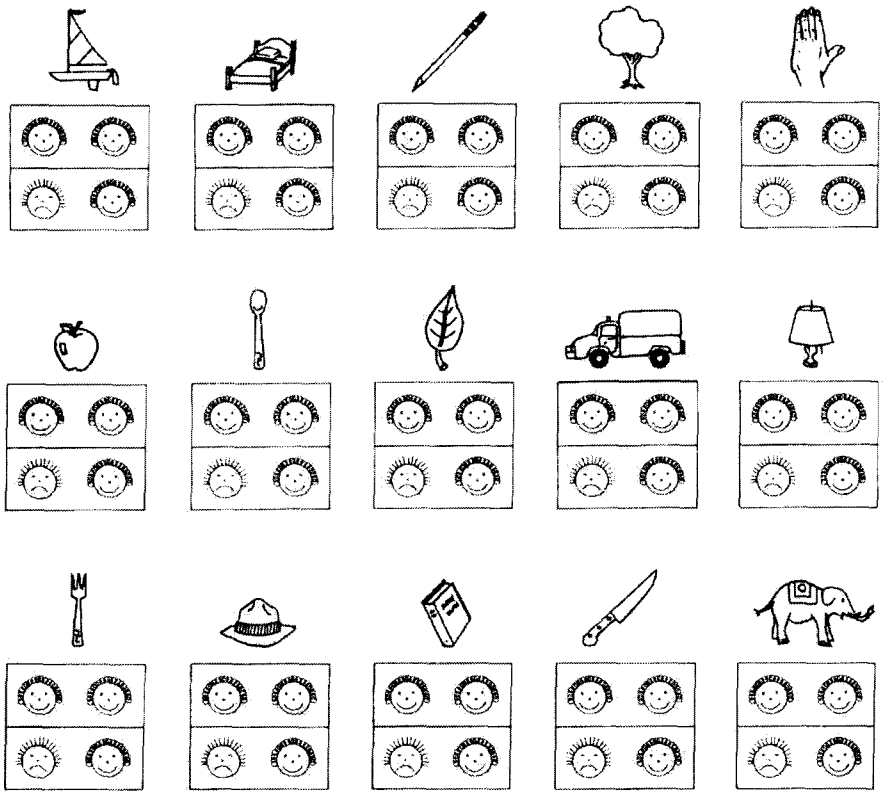
T



APPENDIX D: GORDON'S INTERMEDIATE MEASURE OF MUSIC AUDIATION'S ANSWER SHEET FOR CHILDREN. RHYTHM TEST

R





APPENDIX E: MUSIC PERCEPTION TEST

MUSIC PERCEPTION TEST

Place a S (Same) or a D (Different) in the appropriated square.

Test T

apple	S	shoe	D	cup	D	tree	S		
1-car		2-hat		3-spoon		4-boat		5-chair	
6-hand		7-cup		8-pencil		9-house		10-knife	
11-eleph.		12-boat		13-apple		14-car		15-shoe	
16-hat		17-chair		18-cup		19-book		20-fork	
21-leaf		22-apple		23-hand		24-knife		25-tree	
26-foot		27-shoe		28-car		29-hat		30-pencil	
31-apple		32-knife		33-eleph.		34-boat		35-house	
36-book		37-pencil		38-leaf		39-spoon		40-cup	

Test R

truck	D	book	S						
1-boat		2-bed		3-pencil		4-tree		5-hand	
6-apple		7-spoon		8-leaf		9-truck		10-lamp	
11-fork		12-hat		13-book		14-knife		15-eleph.	
16-bed		17-cup		18-book		19-spoon		20-shoe	
21-car		22-boat		23-knife		24-eleph.		25-tree	
26-hand		27-pencil		28-hat		29-fork		30-truck	
31-book		32-leaf		33-pencil		34-foot		35-cup	
36-spoon		37-lamp		38-boat		39-shoe		40-apple	

Name: _____ Score: _____/80

APPENDIX F: SPEECH PERCEPTION ANSWER SHEET

SPEECH PERCEPTION TEST

NAME: _____ DATE: _____

CLASS: _____ 1ST LANG: _____

As you listen, you will hear several word being spoken in French.
Please place a tick (√) under the vowel sound that you hear in each word.

A	U	OU	B.	AN	ON	C.	É	È
e.g.	rue	roue	e.g	tant	ton	e.g.	mai	mais
	√				√		√	
1.	___	___	11.	___	___	21.	___	___
2.	___	___	12	___	___	22.	___	___
3.	___	___	13	___	___	23.	___	___
4.	___	___	14.	___	___	24.	___	___
5.	___	___	15.	___	___	25.	___	___
6.	___	___	16.	___	___	26.	___	___
7.	___	___	17.	___	___	27.	___	___
8.	___	___	18.	___	___	28.	___	___
9.	___	___	19.	___	___	29.	___	___
10	___	___	20.	___	___	30.	___	___

APPENDIX G: LIST OF WORDS FOR THE SPEECH PERCEPTION AND VOWEL PRODUCTION TEST.

Production test

Please Read the following words. In order not to influence the prononciation, these words are not spelled correctly.

nou	ron	jè
vu	ran	tè
su	pon	né
sou	von	jé
ju	can	tè
lou	pon	jé
nu	san	rè
vou	van	té
lu	pan	pré
jou	son	né

Thank you very much for your participation.

Caroline Morgan-Carter

APPENDIX H: EVALUATION SHEET FOR THE GRADUATE STUDENT FOR THE MUSIC PRODUCTION TEST

RESULTS - MUSIC PRODUCTION

Nom de l'étudiant : _____ Date : _____
Groupe : _____

Note 1 :	0	1	2	3	4	5
Note 2 :	0	1	2	3	4	5
Note 3 :	0	1	2	3	4	5
Note 4 :	0	1	2	3	4	5
Note 5 :	0	1	2	3	4	5

Commentaires : _____

Nom de l'étudiant : _____ Date : _____
Groupe : _____

Note 1 :	0	1	2	3	4	5
Note 2 :	0	1	2	3	4	5
Note 3 :	0	1	2	3	4	5
Note 4 :	0	1	2	3	4	5
Note 5 :	0	1	2	3	4	5

Commentaires : _____

APPENDIX I: EVALUATION SHEET FOR THE NATIVE FRENCH SPEAKERS FOR THE ACCENT PRODUCTION TEST

RESULTS - CONVERSATION

Nom de l'étudiant : _____ Date : _____
Groupe : _____

1 2 3 4 5
Commentaires : _____

Nom de l'étudiant : _____ Date : _____
Groupe : _____

1 2 3 4 5
Commentaires : _____

Nom de l'étudiant : _____ Date : _____
Groupe : _____

1 2 3 4 5

Commentaires : _____

APPENDIX J: EXAMPLE OF THE FREQUENCIES (Hz) OF NOTES IN THE FOURTH OCTAVE USING THE TEMPERED SCALE

Note (U.S.A. Standard)	Frequency of Tempered Semitones (Hz)	Calculation of Frequency
C_4	261.63	$C_4.2^{0}$
C_4#	277.18	$C_4.2^{1/12}$
D_4	293.66	$C_4.2^{2/12}$
D_4#	311.13	$C_4.2^{3/12}$
E_4	329.63	$C_4.2^{4/12}$
F_4	349.23	$C_4.2^{5/12}$
F_4#	369.99	$C_4.2^{6/12}$
G_4	392.00	$C_4.2^{7/12}$
G_4#	415.30	$C_4.2^{8/12}$
A_4	440.00	$C_4.2^{9/12}$
A_4#	466.16	$C_4.2^{10/12}$
B_4	493.88	$C_4.2^{11/12}$
C_5	523.25	$C_4.2^{1}$

APPENDIX K: MARKING METHOD

(e.g. - When the frequency sung lies between $B.2^{2/60}$ and $B.2^{3/60}$ the mark awarded is 3)

FREQUENCIES BETWEEN A# AND C	MARK AWARDED
	0
$A\# = B.2^{-5/60}$	1
$B.2^{-4/60}$	2
$B.2^{-3/60}$	3
$B.2^{-2/60}$	4
$B.2^{-1/60}$	5
TARGET B	5
$B.2^{1/60}$	4
$B.2^{2/60}$	3
$B.2^{3/60}$	2
$B.2^{4/60}$	1
$C = B.2^{5/60}$	0

FOOTNOTES

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1 This table was not part of Harrison (1979), but her data are presented as a table in this thesis in order to demonstrate the difference between the two groups (the students who were taking music classes and the students who were not taking music classe

2 Other phonemes also cause problems, such as the [R], which is symbolic of the difficulties students have when learning French; nevertheless, I did not include [R], since the problem appears to be articulatory and there is no apparent perceptual confusion between [R] and other phonemes. Another contrast that is sometimes difficult for the students to perceive and produce is [ø/œ], but since this contrast is in complementary distribution in French, minimal pairs would be found only as exceptions, whereas minimal pairs for the contrasts chosen are very common.

3 *A = 440 Hz* is the standard frequency recommended by the International Standards Organization. "Since the notes in the tempered scale are determined by the arithmetics outlined above, we need to fix the frequency of only one note in the scale in order to construct the frequencies for the remaining notes. For some centuries it has been customary to take the frequency of the note A above middle C as the standard of reference...in 1953 the International Standards Organization recommended the adoption of A-440 as the standard frequency throughout the world." (Backus 1969, p. 131-132)

The term 'current music pitch' or 'present day standard of concert pitch' has been used since 1955, whereas previous standards included 435 Hz and others.

4 *Middle C*: "A note placed on the first ledger line above the bass staff represents the same pitch as a note placed on the first ledger line below the treble staff. This note is called middle C. This note is also approximately in the middle of the piano keyboard." (Harder & Steinke 2000, p. 25)

5 For an *equal tempered scale* an octave is divided into 12 equal geometric intervals, so that the frequency ratio corresponding to one semitone interval is the 12th root of 2, or 1.0595. (Backus 1969)

6 Eterno (1961) used the Conn Musical Aptitude Test of rhythm, tempo, pitch, melody, chords (and also vision and mathematics). For the *music perception* test, the participants had to decide whether the pairs heard were the same or different. The *speech production* test was the reading of Spanish words by participants who had had some training in the language.

Brutter et al. (1985) used the Seashore Measure of Musical talents with three sub tests: Seashore test of pitch, Seashore test of loudness and Seashore test of rhythm. These were all music discrimination tests. The Test of Spoken English was used to test pronunciation, grammar, fluency and overall.

Arellano and Draper (1972) used the Seashore measure of Pitch, Intensity, Rhythm and Tonal Memory for music perception as well as a comprehension and production test for Spanish.

Fish (1984) used the Gordon Musical Aptitude Profile for music perception test. The MLA Cooperative Foreign Language Tests and Pimsleur Language Aptitude Battery were used for speech discrimination and production.

7 Any word could have been used. The vowel [a] was chosen because it is an open vowel, which would encourage the students to sing louder.

8 The most current tuning for occidental music uses the 12 steps equally tempered (12ET) tuning. It means each octave is divided into 12 equally spaced (in logarithmic scale) intervals called semitones (see Appendix J): An octave is composed of the notes C, C#, D, D#, E, F, F#, G, G#, A, A#, B, and C, where the frequency of the higher C is exactly twice that of the lower C. Thus, if we consider the note B, which is one of the targets for both men and women, a tone produced above C, or below A#, would be judged as very poor and would merit a mark of zero. If the tone were between A# and C then a mark between 1 and 5 would be awarded in the manner shown below (see Appendix K).

9 When explaining the laterality of the brain (the right–ear advantage), Major (2001) states that language and analytical ability use the left side of the brain, whereas spatial configuration ability, perception of music, and other gestalt-like functions use the right side of the brain. Language and music perception would therefore be found on different sides of the brain. According to Larre (2002), for most people 80% of the language is located in the left side of the brain, and 20% is located in the right side. It is suggested that grammar and vocabulary are in the left side along with mathematics, but the music of the language, the intonation, the rhythm, VOT, and maybe even the phonemes, would be located on the same side as musical ability. It would therefore be possible that people who use their left brain predominantly might have a severe problem both with learning the pronunciation of a second language and with learning music.